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**PHYSICAL ACTIVITY AND QUALITY OF LIFE IN WOMEN
TREATED WITH ROUX-EN-Y GASTRIC BYPASS SURGERY**

A randomized controlled trial and qualitative interviews

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Physical activity and quality of life in women treated with
Roux-en-Y Gastric Bypass surgery:
A randomized controlled trial and qualitative interviews

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ABSTRACT

Introduction: Bariatric surgery is the most effective method for weight loss and long-term weight loss maintenance, but requires several changes in health behaviors. In Sweden, Roux-en-Y Gastric Bypass (RYGB) is the most common bariatric surgery method, as it accounted for 49.3% of the bariatric procedures in 2018. Post-surgery, various psychosocial outcomes typically improves, such as health-related quality of life (HRQoL), but unfortunately the improvements for some outcomes do not remain long-term. Currently, no psychosocial support is offered by the Swedish healthcare post-surgery. Physical activity is important post-surgery as it can improve several outcomes of the surgery, but majority of patients are not sufficiently physically active, and they also in general overestimate their physical activity. There is a knowledge-gap whether the large overestimation of physical activity persists long-term post-surgery, as well as qualitative research about bariatric patients' perceptions of physical activity long-term post-surgery.

Aims: The overall aim of this thesis was to investigate if a dissonance-based intervention could prevent a decline in HRQoL and improve other psychosocial outcomes and physical activity in women two years after RYGB surgery. Additional aims were to investigate the discrepancy between self-reported and objectively measured physical activity 48-months post-RYGB and to explore RYGB-treated women's perceptions of physical activity five years after surgery.

Methods: A randomized controlled trial (RCT), where women undergoing RYGB surgery between 2015-2017, were randomized to either an intervention or a control group. The intervention consisted of four dissonance-based group sessions about physical activity, eating behavior, social- and intimate relationships, conducted three months post-RYGB. Questionnaires and GT3X+ accelerometers were used to assess psychosocial outcomes and physical activity at pre-, one- and two-years post-RYGB.

A longitudinal cohort study recruited women undergoing RYGB surgery between 2012-2013, and pre-, nine- and 48-months post-RYGB they wore accelerometers and self-reported their physical activity levels via a self-administered questionnaire. Some of these women also participated in an interview study five years post-RYGB about their perceptions and experiences of physical activity. A grounded theory approach, inspired by Corbin & Strauss, was applied.

Results: A total of 259 women were recruited to the RCT, of which 156 women were randomized to intervention and 103 to control group. At the two-years follow-up, 203 participants had complete questionnaire data and 167 had valid accelerometer measurements. Seventy-one percent of the participants in the intervention group with valid questionnaire data attended at least one group session. Two years post-RYGB, the effects of the intervention were poor (Cohen's $d = 0.00 - 0.36$) and no significant differences (of clinical

relevance) were seen in HRQoL, eating behavior, body esteem, social adjustment or physical activity levels between the intervention and control groups.

In the longitudinal cohort, 26 women with valid questionnaire and accelerometer measurements from all data assessments were included. They overestimated their time spent in MVPA to a greater extent post- compared to pre-RYGB. Self-reported physical activity increased with 36.5% from pre- to 48-months post-RYGB, while accelerometer measurements instead showed a decrease of 3.5%.

Interviews with 11 women five years post-RYGB revealed that women who had positive attitudes towards physical activity, together with high social support, perceived themselves as regularly physically active. The opposite was seen in women with negative attitudes who experienced low social support. Some of the women presented shifting attitudes, moving between episodes of physical activity with positive attitudes and episodes of inactivity, and with support from e.g. partners but not in the way they had preferred. Also, majority of the women perceived exercise and physical activity only as a mean to lose weight.

Conclusions: A dissonance-based group intervention did not have any effect on HRQoL, eating behavior, body esteem, social adjustment or physical activity levels two years post-RYGB. However, longer follow-up time might be necessary in order to see any effects, as all psychosocial outcomes for both groups improved from pre- to one-year and were maintained at the two-years follow-up.

The greater discrepancy between subjective and objective measured physical activity post-bariatric surgery, previously seen up to nine months post-RYGB, remained at 48-months post-RYGB.

Attitudes towards physical activity post-RYGB, together with social support, seems to be related to RYGB-treated women's perceived levels of physical activity five years post-RYGB. A majority of the women expressed that physical activity was just necessary when wanting to lose weight.

LIST OF SCIENTIFIC PAPERS

- I. Possmark S, Sellberg F, Ghaderi A, Tynelius P, Willmer M, Rasmussen F, Persson M, Berglind D.
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- IV. Possmark S, Berglind D, Sellberg F, Ghaderi A, Persson M.
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CONTENTS

1	INTRODUCTION.....	1
2	BACKGROUND	3
2.1	OBESITY	3
2.1.1	Health consequences of obesity	3
2.2	OBESITY TREATMENT OPTIONS	4
2.2.1	Lifestyle changes	4
2.2.2	Bariatric surgery.....	4
2.3	LIFE AFTER BARIATRIC SURGERY	7
2.3.1	Physiological effects	7
2.3.2	Physical activity	8
2.3.3	Health-Related Quality of Life.....	10
2.3.4	Eating behavior	11
2.3.5	Body esteem and body image.....	12
2.3.6	Social adjustment.....	12
2.3.7	Other psychosocial outcomes	13
2.4	PREVIOUS INTERVENTIONS TO IMPROVE PHYSICAL ACTIVITY AND PSYCHOSOCIAL OUTCOMES AFTER BARIATRIC SURGERY	15
2.5	DISSONANCE-BASED INTERVENTIONS.....	16
3	AIMS.....	19
4	METHODOLOGICAL CONSIDERATIONS.....	21
4.1	OVERVIEW	21
4.2	STUDIES I - II: THE WELL-GBP TRIAL	21
4.2.1	Recruitment and data collection	21
4.2.2	The WELL-GBP intervention	23
4.3	STUDY III: THE LONGITUDINAL COHORT STUDY	25
4.3.1	Recruitment and data collection	26
4.4	STUDY IV: THE INTERVIEW STUDY	26
4.4.1	Recruitment and data collection	27
4.5	MEASUREMENTS AND OUTCOMES.....	28
4.5.1	Questionnaires.....	28
4.5.2	Accelerometers	31
4.6	DATA ANALYSIS	32
4.6.1	Studies I - II (statistical analysis)	32
4.6.2	Study III (statistical analysis)	33
4.6.3	Study IV (qualitative data analysis)	34
4.7	ETHICAL CONSIDERATIONS	34
5	RESULTS.....	37
5.1	STUDY I: WELL-GBP AND HEALTH-RELATED QUALITY OF LIFE	37

5.2	STUDY II: WELL-GBP AND PHYSICAL ACTIVITY	39
5.3	STUDY III: SUBJECTIVE AND OBJECTIVE PHYSICAL ACTIVITY	42
5.4	STUDY IV: ATTITUDES TOWARDS PHYSICAL ACTIVITY	46
6	DISCUSSION.....	49
6.1	STUDIES I - II: WELL-GBP, HEALTH-RELATED QUALITY OF LIFE AND PHYSICAL ACTIVITY.....	49
6.1.1	Main findings	49
6.1.2	Results in relation to previous research.....	49
6.1.3	Methodological considerations.....	51
6.2	STUDY III: SUBJECTIVE AND OBJECTIVE PHYSICAL ACTIVITY	54
6.2.1	Main findings	54
6.2.2	Results in relation to previous research.....	54
6.2.3	Methodological considerations.....	56
6.3	STUDY IV: ATTITUDES TOWARDS PHYSICAL ACTIVITY	57
6.3.1	Main findings	57
6.3.2	Results in relation to previous research.....	57
6.3.3	Methodological considerations.....	59
6.4	IMPLICATIONS OF FINDINGS	60
7	CONCLUSIONS	63
8	POPULÄRVETENSKAPLIG SAMMANFATTNING	65
9	ACKNOWLEDGEMENTS	67
10	REFERENCES	69

LIST OF ABBREVIATIONS

%EBMIL	Percentage Excess BMI loss
%TWL	Percentage Total Weight Loss
BES	Body Esteem Scale
BES-APP	BES-Appearance
BES-ATT	BES-Attribution
BES-W	BES-Weight
BMI	Body Mass Index
cpm	Counts per minute
DEBS	Disordered Eating after Bariatric Surgery
DBI	Dissonance-Based Intervention
GT	Grounded Theory
HRQoL	Health-Related Quality of Life
ITT	Intention-To-Treat
LPA	Light Physical activity
MCS	Mental Component Summary score
MVPA	Moderate-to-Vigorous Physical Activity
PCA	Physical Component Summary score
PP	Per-Protocol
RCT	Randomized Controlled Trial
RYGB	Roux-en-Y Gastric Bypass
SAS-SR	Social Adjustment Scale – Self Reported
SD	Standard Deviation
SE	Standard Error
SF-36	36-item Short Form Health Survey
SG	Sleeve Gastrectomy
SOReg	Scandinavian Obesity Surgery Registry
TFEQ	Three-Factor Eating Questionnaire
TFEQ-CR	TFEQ-Cognitive Restraint
TFEQ-EE	TFEQ-Emotional Eating
TFEQ-UE	TFEQ-Uncontrolled Eating

WELL-RYGB

Wellbeing after RYGB

WHO

World Health Organization

1 INTRODUCTION

It cannot have evaded anyone that the prevalence of obesity has increased the last decades and has become a vast public health problem, affecting all ages, genders and countries [1]. Only today in Sweden, half of the adult population has overweight or obesity. Sadly, a common misperception about obesity in the society is, that it is strictly the fault of the individual, who lacks discipline, self-control and knowledge. This misperception causes stigmatization and leaves the affected individual with guilt and shame [2]. On the contrary, much of the cause can be traced to what has been called the obesogenic environment: a constant availability and abundance of cheap, processed and high caloric food, together with a community planning where all spontaneous physical activity has been built away and, instead, replaced with escalators, elevators, cars and sedentary workplaces [3, 4]. In addition, obesity is inherited, causing some individuals to be more susceptible to obesity [5, 6].

Bariatric surgery is the most effective treatment for obesity, with long-term results of weight maintenance and improvements in various health outcomes [7-11]. However, to maintain the positive effects of the surgery, a patient is required to adapt to several new lifestyle behaviors, for example an eating behavior with adjusted dietary intake including any additional psychosocial challenges. To become physically active can enhance the positive effects from the surgery. Also, a bariatric patient needs to learn how to cope with comments and opinions from one's social environment.

Many patients that undergo bariatric surgery experiences several psychosocial impairments prior to surgery, which during the first year often significantly improves, but are not maintained long-term [12-16]. Also, bariatric patients are not sufficiently active prior to surgery as they usually have low levels of physical activity, which often remains post-surgery. Interestingly though, patients believe they become more active post-surgery, as studies have shown that the overreporting of physical activity is greater after surgery, than before [17-19]. Why this is, is not known.

In Sweden, prior to surgery, patients undergo several steps before being approved for surgery, such as medical examinations and meetings with nurses and surgeons. However, after the surgery is completed, patients are in many ways left on their own to figure out their new lifestyle changes and behaviors, which is not always easy without the right support. Even if patients have expressed a need for more psychosocial support post-bariatric surgery [20], there is currently no such support provided by the healthcare in Sweden.

We therefore developed a short intervention, the WELL-GBP trial, with the aim to maintain and increase health-related quality of life and other psychosocial outcomes, as well as physical activity, to give bariatric patients an additional support post-surgery to help them change lifestyle behaviors and to handle future psychosocial challenges. This thesis includes the results from this intervention, together with results from a four-year follow-up of self-reported and objectively measured physical activity, as well as interviews about patients' perceptions of physical activity five years after their surgery.

2 BACKGROUND

2.1 OBESITY

Overweight and obesity is defined by the World Health Organization (WHO) as abnormal or excessive fat accumulation that may impair health [1]. Body mass index (BMI) is often used to classify overweight and obesity, and it's an index of weight-for-height, calculated as kg/m^2 [1]. In adults, overweight and obesity is classified as a BMI of ≥ 25 and ≥ 30 , respectively, and normal weight ranges between a BMI of 18.5 – 24.9.

In 2016, 39% (1.9 billion) of the adults worldwide had overweight, of which 13% (659 million) had obesity [1]. The prevalence of obesity has increased during the last decades, as 10.8% of the men and 14.9% of the women globally had obesity in 2014, whereas in 1975, the prevalence was 3.2% and 6.4%, respectively [21]. Children and adolescents worldwide also have increasing trends of overweight and obesity [22]. Today, overweight and obesity are linked to more deaths globally than underweight [1], thus has overweight and obesity become a global pandemic and a great threat to health [4].

The global increase of overweight and obesity has also been observed in Sweden, as the prevalence of obesity has tripled since the 1980s [23]. In 2018, the prevalence of overweight and obesity were around 50% in the adult Swedish population, were 16% of the men and 15% of the women had obesity. A higher prevalence of obesity is observed among people with lower levels of education, even if the prevalence has increased for all education levels [24]. In Stockholm County today, the prevalence of overweight and obesity is 45% among all adults, 38% among women and 53% among men [23].

The increase of overweight and obesity is caused by an imbalance between energy intake and energy consumption, and not by changes in any genes [3]. A big part of the imbalance are caused by the obesogenic environment, which include community planning as well as changes in the global food system, that has increased the availability and decreased the prices of processed foods rich in sugar, fat and calories which has low nutritional quality [3, 4]. The community planning entails that escalators and elevators have been replaced instead of stairs, we take the car instead of walking and have sedentary workplaces, with the consequences that all spontaneous physical activity has been reduced [3, 4]. However, obesity and genetics is associated as obesity is inherited, with consequences that some individuals are more susceptible to become obese, especially when living in an obesogenic environment [5, 6].

2.1.1 Health consequences of obesity

There are several health consequences of being overweight and obese, as especially obesity increases the risk for cardiovascular diseases, hypertension, stroke, type 2 diabetes as well as certain types of cancer [25]. Overweight and obesity is the second leading metabolic risk factor for death worldwide (elevated blood pressure is number one), and in 2010, overweight and obesity were estimated to have caused 3.4 million deaths per year [25]. In Stockholm County, 12% of all deaths in 2019 was caused by overweight and obesity [23].

There are also psychological consequences of overweight and obesity, as numerous mental health issues have been associated to excess body weight. One example is depression [26], where the association between obesity and depression seems to be stronger among women than men [27]. Other related mental health issues are anxiety, body image dissatisfaction, eating disorders [26] and decreased health-related quality of life (HRQoL) [28, 29]. Moreover, people with overweight and obesity are often stigmatized in the society [2, 30]. Weight stigma has been positively associated with physiological outcomes like obesity, risk for diabetes, cortisol levels and oxidative stress levels, as well as psychological outcomes such as eating disorders, body image dissatisfaction, anxiety, depression and decreased self-esteem [30].

As children with obesity has a higher risk of becoming obese even as adults [1], it is important to stop the worldwide increasing trend of overweight and obesity. Because of the obesogenic environment, the causes of obesity are complex, and prevention needs to be done in various societal levels and policies [3, 4, 21]. However, there are treatments options available for individuals with obesity.

2.2 OBESITY TREATMENT OPTIONS

2.2.1 Lifestyle changes

A recent systematic review that included interventions of obesity treatments, that were non-surgical and non-pharmacological, for individuals with obesity showed that interventions with at least three-years follow-up, with no continued or additional treatment aside from the initial intervention, were not successful. The participants initially lost weight, but the majority of participants later experienced weight regain back to their pre-treatment weight [31].

One systematic review, investigating behavioral interventions with either diet or physical activity on weight loss maintenance, did not show any effect, while interventions including both diet and physical activity showed small effects of weight loss maintenance at 12 months post-treatment [32]. Another review that investigated interventions on weight loss maintenance after initial weight loss, found that only a small number of studies had any significant intervention effects, and that weight maintenance is complex and might need several different approaches and methods [33].

To summarize, long-term effects of lifestyle interventions that aims for weight loss or weight loss maintenance, is not successful.

2.2.2 Bariatric surgery

2.2.2.1 The different techniques of bariatric surgery

Bariatric surgery has proven to be the most successful method for weight loss and weight loss maintenance, compared to non-surgical treatment [7-11]. There are several different bariatric surgery techniques, but the background of this thesis mainly focuses on two of them: Roux-en-Y Gastric Bypass (RYGB) and sleeve gastrectomy (SG). That is because they are the most

popular techniques used, and RYGB is the method used on all participants in the four studies. However, a short summary of some of the other methods are provided below.

The different techniques used in bariatric surgery are commonly divided into the two categories “restrictive procedures” and “malabsorptive and restrictive procedures”. A “restrictive procedure” limits the food intake but does not alter with the intestinal anatomy. Examples are vertical banded gastroplasty and adjustable gastric banding (Figure 1A). These are not commonly performed anymore globally [34], and not at all in Sweden [35], because of the long-term post-surgery complications and the high rates of weight regain [34].

“Malabsorptive and restrictive procedures” changes the intestinal anatomy while also limits the food intake. Examples are RYGB (Figure 1B), biliopancreatic diversion with duodenal switch (Figure 1C) and SG (Figure 1D). Biliopancreatic diversion with duodenal switch is often only used for patients with “superobesity”, defined by a BMI ≥ 50 kg/m² [8]. Around 40-50 operations with this technique have been conducted annually during the last ten years in Sweden [35].

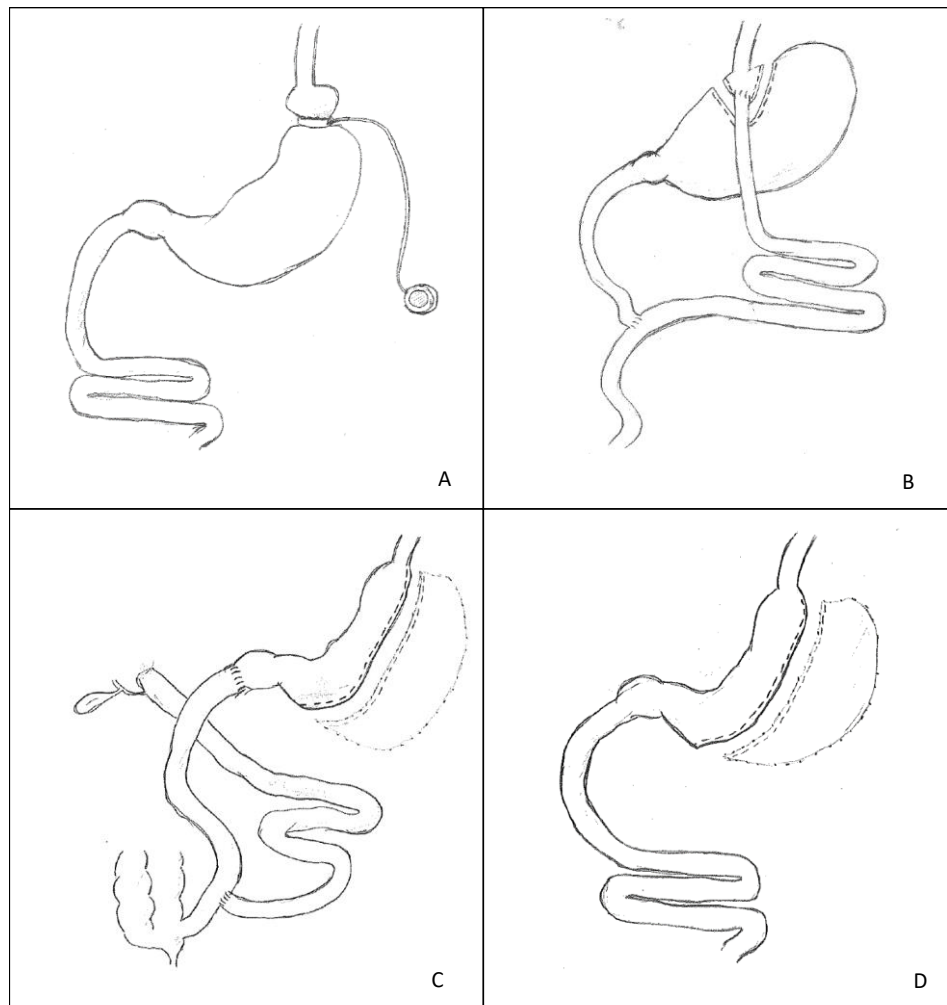


Figure 1. Some of the different bariatric surgery techniques. A) Adjustable Gastric Banding; B) Roux-en-Y Gastric Bypass; C) Biliopancreatic Diversion with Duodenal Switch; D) Sleeve Gastrectomy. (Illustration: Fanny Sellberg)

RYGB is done by reducing the upper stomach to a small pouch by stapling off the upper stomach, which reduces the amount of food that can be consumed, and then directly attach the pouch to the middle part of the small intestine. The food eaten are then bypassing the upper part of the small intestine, which reduce the uptake of fat, calories, vitamins and minerals [36].

SG is a less complicated procedure than RYGB. Around two-thirds of the stomach is removed, which makes the stomach tube-shaped. Because of the reduced size of the stomach, less food can be consumed and thus leads to weight loss [36].

Laparoscopic techniques are used in 99% of all bariatric procedures in Sweden [35]. A Swedish study demonstrated that bariatric surgery in Sweden is safe, with a 90-day mortality of 0.06% and one-year mortality of 0.19% [37]. Three percent of the patients that undergo bariatric surgery in Sweden are affected by a severe complication post-surgery [35].

2.2.2.2 Prevalence and demographic data

One of the first procedures of the RYGB technique was done around 1977, and the first laparoscopic RYGB was conducted in 1994 [34]. For several years, RYGB was the most common type of bariatric surgery worldwide [38]. But today, SG is the most common procedure globally as in 2016, 53.6% of the procedures consisted of SG, followed by RYGB (30.1%) [39]. An overview of the global demographic data of bariatric surgeries conducted worldwide between 2013 to 2015, showed that mean age was 42 years and that 73.3% of all bariatric patients were women [38].

In Sweden, contrary to the global prevalence, RYGB is still the most common procedure, as 49.3% of the total 5 200 bariatric procedures conducted in 2018 were RYGB and 45.2% were SG [35]. In 2015, which is the start of the intervention that this PhD project is based on, RYGB accounted for 70.8%, and SG only 27.1%, of the total 6 200 bariatric procedures performed [40]. Mean age of the patients that undergo bariatric surgery in Sweden is around 40.9 years [35] and the majority of the patients are women; 75,6% in 2014 [41] and 77.8% in 2018 [35].

To be eligible for bariatric surgery in Sweden, a patient must be ≥ 18 years old, have made previous serious attempts of losing weight on their own, no present eating disorders and have a BMI $\geq 40 \text{ kg/m}^2$, or, if there are present comorbidities (for example type 2 diabetes); a BMI $\geq 35 \text{ kg/m}^2$ [42]. However, a surgeon and/or nurse always do individual assessments to decide if a patient is eligible and regional differences between hospitals exists.

Sweden has a national registry, Scandinavian Obesity Surgery Registry (SOReg), where all bariatric procedures are registered since 2007. Each year they publish reports from previous year with statistics about prevalence of surgeries and techniques performed, weight, post-surgery complications, HRQoL etc. SOReg performs regular cross linkages with the Swedish National Board of Health and Welfare to assess the completeness of the data.

2.3 LIFE AFTER BARIATRIC SURGERY

2.3.1 Physiological effects

Globally, total weight loss at one-year post-surgery has been 30.5% [38]. Long-term weight loss has been 35.0% at two-years, 28.0% at six-years and 26.9% at 12-years follow-ups [7]. A study with a 10-year follow-up showed a total weight loss of 24.1% and total excess weight loss of 53.0% [43]. Report from SOReg shows that the mean percent weight loss in Swedish bariatric patients at one-, five- and 10-years post-RYGB is 32.0% (SD = 7.6), 28.5% (SD = 9.8) and 25.1% (SD = 11.0), respectively, and the percentage excess BMI loss (%EBMIL) is 82.2% (SD = 32.1), 72.5% (SD = 26.1) and 62.2% (SD = 28.6), for respective follow-up [44].

Bariatric surgery is associated with decreases in various comorbidities. For example, remission of type 2 diabetes is common [7-9, 43, 45], with remission rates of 75% and 51% at two- and 12-years follow-up, respectively [7]. A study from Sweden showed that the remission of type 2 diabetes was 76.6% at two-years and 49.9% at five-years post-surgery [46].

Other comorbidities that improves post-bariatric surgery are hypertension [7, 43, 47], dyslipidemia [7, 43], as well as all-cause- [10, 11], cardiovascular- and cancer-related mortality [11]. A meta-analysis on bariatric surgery and effect on cancer risk found associations with decreased risk for cancer in both incidence and mortality [48]. Bariatric surgery has also been shown to decrease the intensity of low back symptoms and disability [49].

2.3.1.1 *Comparison between Roux-en-Y Gastric Bypass and Sleeve Gastrectomy*

Since SG is a fairly new method that has gained popularity over RYGB globally in recent years, research that compare the safety and long-term results between SG and RYGB are of interest, and several reviews and meta-analysis have been conducted on this topic [50-52].

Patients that underwent SG have experienced fewer post-surgery complications as well as lower re-operation rate than RYGB [50-52]. RYGB had significantly greater percentage excess weight loss at three and five years post-surgery compared to SG [50, 51, 53], but no difference was seen during the first two years post-surgery [50]. Another meta-analysis showed only small differences between RYGB and SG regarding excess weight loss, mid-term and long-term weight loss, when the follow-up was at least one-year post-surgery [52].

There were no differences in long-term remission of type 2 diabetes between the two methods [50-52]. However, RYGB had better remissions in comorbidities such as dyslipidemia, hypertension and gastroesophageal reflux disease [50-53]. One review showed no difference in remission of these comorbidities at mid- and long-term (>3 years) post-surgery [50], while another meta-analysis showed that RYGB were superior SG in regard to comorbidities like type 2 diabetes, hypertension and dyslipidemia at five years post-surgery [53]. No difference between RYGB and SG was found in outcome of HRQoL [50].

In conclusion, RYGB seems to be superior SG in regard to long-term excess weight loss and long-term improvements in comorbidities but is associated with more complications post-surgery than SG.

2.3.2 Physical activity

2.3.2.1 Overall information about physical activity

Physical activity is defined as “any bodily movement produced by skeletal muscles that results in energy expenditure”. Physical activity can be divided into categories of daily life physical activity such as occupational or household activities, or exercise, which is a sub-type of physical activity that is planned, structured and repetitive with the aim to improve or maintain components of physical fitness [54].

Previously, global physical activity guidelines for adults recommended ≥ 150 min per week of MVPA in bouts for at least 10-min [55]. However, the guidelines from WHO and the United States have now been revised, and the new guidelines still includes the minimum MVPA-levels of ≥ 150 min per week, but without the bouts [56, 57].

Physical activity is associated with several health benefits as it reduces the risk of diabetes, hypertension, coronary heart disease, stroke, some types of cancer, premature mortality and depression [55, 58]. Moderate-to-vigorous physical activity (MVPA) also has additional health benefits as well as reduced mortality [59]. A recent study has shown that higher levels of physical activity, regardless of the intensity, together with less sedentary behavior has a reduced risk for mortality [60]. A systematic review of current systematic reviews shows that health benefits can be achieved after just minor physical activity, i.e. levels that are below the current physical activity guidelines, and the authors concluded that the current physical activity guidelines may therefore be a barrier for some people to become physically active [61].

To be fit, i.e. to have a high cardiorespiratory fitness, can reverse some of the consequences of obesity, and physical activity has been shown to correlate with several health benefits, independent of adiposity and BMI [62]. This has been called the “fat but fit paradox”. To be physically active is also an important predictive determinant for weight loss maintenance [63].

Majority of the general population in Sweden is not sufficiently active, as self-reported data show that 64 % of the population meet the physical activity guidelines [24], and in Stockholm the prevalence is 55 % [23]. An important note is, however, that self-reported data on physical activity is not completely reliable, thus the prevalence of meeting the physical activity guidelines among the general Swedish population may therefore be lower than reported [64]. Also, when physical activity has been measured with objective tools such as accelerometers, a twofold stronger association to adiposity has been seen, compared to physical activity that is self-reported [65]. Therefore, in order to understand the long-term

health consequences of physical activity, it is of importance to measure physical activity in a way that is as close to the truth as possible.

2.3.2.2 Physical activity after bariatric surgery

To be sufficiently physically active is especially important for patients that have undergone bariatric surgery. Several systematic reviews and meta-analysis have found that exercise post-bariatric surgery is associated with greater weight loss, greater fat mass loss [66], improved cardiorespiratory fitness [66, 67] and functional walking [66]. Another meta-analysis was conducted on RCTs including physical activity after bariatric surgery, and found that patients that exercised after their surgery lost an additional of 1.94 kg and could walk 29.7 meters longer during a “six min walk test” compared to patients that didn’t exercise post-surgery [68]. Other studies have found that exercise post-surgery could prevent a decrease in muscle mass and increase muscle strength post-surgery [69] and maintain the skeletal muscle mass, despite losing more weight and fat mass [70]. A recently published study, conducted on the participants in the control group of the WELL-GBP trial, found that there was an association between meeting the physical activity guidelines and higher HRQoL at pre- and one-year post-RYGB [71].

Studies using objective measures, such as accelerometers, has shown that bariatric patients are not sufficiently active post-surgery, as their levels of physical activity or MVPA do not change from pre- to post-surgery [18, 19, 72-76], or that physical activity increases to a small extent [77, 78]. However, when bariatric patients self-report their physical activity after surgery, they report that their levels of physical activity have increased, often to a large extent [79]. Some studies have compared self-reported physical activity to accelerometer measured physical activity within the same individuals pre- and up to nine months post-surgery and, interestingly, have seen that the objective physical activity levels did not change, while the self-reported physical activity significantly increased [17-19, 80].

In conclusion, bariatric patients who are physically active can lower the risk for weight regain.

2.3.2.3 Qualitative studies on physical activity after bariatric surgery

The qualitative research that explore the experiences bariatric patients have about physical activity post-surgery is quite limited and mostly focuses on different barriers and/or facilitators patients encounter for being physically active. Follow-up time have been around one year [81-83, 88], two years [84, 85] and five years [86, 87] post-bariatric surgery. Common facilitators for becoming more active post-surgery are: it is easier to move around when the excess weight is lost [81-83, 86, 87], having more energy [81, 87], having a feeling of happiness and more satisfaction of being able to move [81, 82, 86], having social support [82, 83, 85, 88], motivation to be active [81], a decrease in bodily pain [81, 82], do not feel out of breath anymore and therefore can do more everyday physical activity [81] and being able to participate in social and family activities [81, 88].

Despite these facilitators, many patients are not sufficiently physically active, and the most common mental or internal barriers consists of: lack of support [81-84, 86, 88], low motivation or think it's boring [81-84, 87], lack of time or do not prioritize exercise [82-84, 88], bad weather [81, 84, 88] or financial reasons [81, 88]. Physical barriers consists of: a sense of a need to lose more weight before being able to exercise [81], diarrhea or diet-related problems [81, 84]. Excess skin is common post-surgery and can be uncomfortable and cause pain [81, 83, 88], enormous sweating [86] as well as having negative psychological and social consequences [81, 82, 86].

Interview studies that have been done with patients before their surgery has shown that many patients experience obesity-related barriers for being able to engage in physical activity, but believes that being able to lose weight after bariatric surgery will be the main facilitator for becoming active [89, 90]. However, many barriers pre-surgery were not related to the obesity itself, but rather to circumstances such as low motivation and lack of support and time. These barriers might still be present post-surgery and therefore remain despite of weight loss [89]. One interview study showed that even if bariatric surgery patients have gained knowledge and practical experience of physical activity and have an intention of becoming more physically active, it does not necessarily mean that they will take the essential steps to become more active one year later [88].

To summarize, despite weight loss post-surgery, many patients struggle with different psychological and physical barriers that are not related to the obesity itself, which might explain the low adherence to the physical activity guidelines.

2.3.3 Health-Related Quality of Life

Overall HRQoL improves substantially after bariatric surgery [91], particularly during the first year [92, 93]. Some studies have shown that HRQoL is related to percentage total weight loss (%TWL) [91, 94].

HRQoL comprises one physical component of HRQoL and one mental component. Before bariatric surgery, many bariatric surgery candidates have low HRQoL in both components [14, 95], which both improves short-term post-surgery. However, after one year, the mental HRQoL starts to decline to around five years post-surgery, where stabilization usually occurs [12-16]. When mental HRQoL is compared to the general population there are some contradictions, as some scales show higher scores after bariatric surgery, while other HRQoL scales shows lower scores than the general population [15].

The physical part of HRQoL, however, significantly increases post-bariatric surgery and remains high long-term [13, 16, 96, 97]. This improvement is likely due to the surgery induced weight loss and the decreases in comorbidities which lead to increased mobility. One study, with a follow-up of 11.5 years post-RYGB, found that RYGB patients had higher scores in the physical domains of HRQoL than their matched controls with obesity, but had significantly lower scores than the general population [98].

Women seems to have lower HRQoL post-surgery, compared to men [98, 99]. One study by Mantziari et al. investigated if post-surgery HRQoL differed in patients belonging to different age groups (<40, 40-54 and >55 years), but found that the improvements in HRQoL after a 10-year follow-up were similar between all the age groups [100].

To summarize, physical HRQoL increases post-surgery and remains high long-term, while the mental HRQoL increases during the first-year post-surgery but is not maintained long-term.

2.3.4 Eating behavior

Eating behavior usually improves post-bariatric surgery [101], but some eating behaviors deteriorate post-surgery, which can lead to poorer weight maintenance [95, 102, 103]. For example, it is common that patients do not adhere to dietary guidelines [102], increase their calorie intake over time, goes back to pre-surgery eating behaviors long-term post-surgery [102] and have present eating disorders [95, 102, 103]. One study showed that patients that had high adherence to the dietary guidelines had, at 92 weeks post-surgery, lost 4.5% more weight compared to the patients with low adherence [104]. A systematic review about frequent snacking behavior found associations between frequent snacking and weight regain post-bariatric surgery, and the prevalence of frequent snacking behavior in the five included studies ranged between 17 - 47% [105].

Studies using subjective measures to assess eating behavior may be taken with some caution, as patients might be prone to underestimate their caloric intake post-surgery [95]. Also, patients don't change their food preferences after surgery, but instead eat smaller portions of the same foods six months post-surgery [106]. Though, two-years post-surgery, they seem to increase their food intake to almost pre-surgery levels [107]. One review by Nance et al. from 2020 [108] showed that patients self-reported a change in intake of energy-dense foods, like decreased sweets and fats, and also decreased their cravings for that kinds of foods. However, these results were not supported by objective measures, which did not find any changes in the preferences of energy-dense foods [108].

A recent review from 2019 by Conceição et al. [109] on eating disorders after bariatric surgery, describes how some patients might need extra support to not develop new disordered eating behaviors, even if disordered eating usually decreases post-surgery. They conclude that patients should be screened for risk behaviors and offered personalized care for patients in risk, and that the assessment tools need to be tailored for bariatric surgery patients [109]. Binge eating seems quite uncommon short-term after surgery but might return with time [110].

To conclude, eating disorders usually decreases post-surgery, but poor eating behaviors may arise, which can have a negative impact on especially weight regain post-surgery.

2.3.5 Body esteem and body image

Body image and body esteem are described as one's self-evaluation of one's appearance or body [111]. Body image improves significantly post-bariatric surgery, where some aspects of the improved body image are generally maintained long-term, while other aspects remain more uncertain or do not improve [111-113]. A systematic review by Bertoletti et al. [111] showed that improvements in body image after bariatric surgery was seen to be associated with higher HRQoL. On the contrary, a negative development of body image was associated with impairments in different psychosocial outcomes, like depressive symptoms, loss of eating control, social discrimination and bullying [111]. Another systematic review [112] concluded that body image post-surgery is quite complex as it can consist of several elements. However, general improvements in body image can be seen (for example in body dissatisfaction and -distortion), while other areas of body image do not improve post-surgery. Other variables such as eating disorders could also generate body image dissatisfaction [112].

Because of the rapid weight loss bariatric patients often experience, their bodies might change faster than their own view of themselves: i.e. these patients can still view themselves as obese, despite the great weight loss [114]. This can be problematic, as it can both be psychologically troublesome for the patients and has been associated with lower HRQoL [114].

Bertoletti et al. concluded in their systematic review that many questionnaires that are used to measure body image are not targeted for bariatric patients, as they lack questions about excess skin [111]. Excess skin is caused by the rapid and fast weight loss post-surgery and is very common: around 80% of the patients experiences it [115-117]. The abdomen, the upper arms and the inside of the thighs are the areas of the body where excess skin is most prevalent [116, 117]. A review by Baillot et al. [115] concluded that excess skin can cause several psychological and physical challenges for the patient, such as body image dissatisfaction, feelings of embarrassment, depressive symptoms, flapping/wobbling skin, pain, perspiration and bad odor as well as various skin problems like rashes, irritations and fungal infections [115]. One study by Biorserud et al. [118] showed that patients who experienced high discomfort due to excess skin also had significantly lower self-image and HRQoL, compared to patients who experienced low discomfort. Another study by Elander et al. [119] showed that excess skin is a problem for both adults and adolescents post-surgery, but that abdominoplasty decreased the discomfort.

In summary, body image generally improves after bariatric surgery, but some aspects like excess skin can cause impairments in body esteem, which in turn can have a negative impact on HRQoL and self-image.

2.3.6 Social adjustment

A few studies have been conducted on social relationships post-bariatric surgery. Overall, it seems like bariatric surgery patients experiences improvements in their quality of social relationships post-surgery, especially in their romantic relationships [120] and sexual

functioning [121]. Sarwer et al. showed that quality of intimate relationship and sexual function improved during the first three years post-surgery, but were not maintained at four years [113]. One study that compared RYGB patients to matched controls seven years post-RYGB, found no difference in satisfaction of social and familial relationships, work, household activities or sexual performance [122]. Another study found that the bariatric patients who were in a relationship both pre- and seven years post-surgery (it was not stated if it was with the same partner or not) and had improved their relationships, had significantly greater %EWL seven years post-surgery [123]. Two interview studies found that bariatric patients expressed that the surgery had affected their family, partner [124, 125] and other social relationships [125] and that the changes was often, but not always, in the positive direction [124, 125].

To conclude, there is a knowledge gap about social adjustment and changes in social relationships pre- and post-bariatric surgery, and further research in this area is therefore important.

2.3.7 Other psychosocial outcomes

There are many psychosocial variables that can be problematic post-bariatric surgery, and the variables presented above are all included in the four studies of this thesis. However, there are also other common problematic psychosocial areas post-surgery that are of importance to be aware of. Some of them are briefly described below.

2.3.7.1 Depression and anxiety disorders

A systematic review by Gill et al. [126] on the long-term effect on depression and anxiety after bariatric surgery, showed that depressive symptoms were significantly reduced ≥ 24 months post-surgery compared to pre-surgery. Symptoms of anxiety was also reduced when measured long-term [126]. However, one of the included studies showed that the levels of depression were back to, and even exceeded, pre-surgery levels when measured seven years post-surgery [127]. The systematic review by Gill et al. [126] included studies that presented prevalence's of depression symptoms between 32.7% - 45% at pre-surgery and between 14.3% - 17.5% at two-years post-surgery. Prevalence of anxiety symptoms were 16.8% at pre-surgery and reduced to 14.3% at two-years follow-up [126]. Even if the prevalence of depression and anxiety decreases, some subgroups of patients seem to be at risk for new onset of depression, as well as suicide [128].

A systematic review [110] on psychological outcomes post-bariatric surgery concluded that depression symptoms reduced from pre- to 24-months follow-up, but thereafter (36-, 48- and 60-months follow-up) the symptoms increased and, in some cases, even went back to pre-surgery levels. The same pattern was seen for anxiety symptoms for most of the patients, but some studies did not find any changes in prevalence of anxiety symptoms [110]. Post-surgery weight loss and changes in anxiety do not seem to be associated, but some studies have found negative correlations between depressive symptoms and post-surgery BMI [126].

A recent systematic review and meta-analysis on the risk of suicide after bariatric surgery, revealed that bariatric patients had a higher risk of suicide, compared to matched controls (matched for age, sex and BMI) as well as the general population. For bariatric patients, the risk for suicide was increased 24-fold, compared to the general population [129]. One study from Sweden by Lagerros et al. [130] showed that the risk of suicide was 4.5 times higher among women treated with RYGB, compared to Swedish women of the same age in the general population. That study also found that depression post-RYGB increased, but that it might relate to whether or not the women already had depression pre-surgery [130].

In conclusion, symptoms of depression and anxiety often improve post-surgery, but also often reemerge during the following years, however the research shows contradictory results regarding long-term results. This might indicate the need of medical attention to the mental health of women planning to undergo bariatric surgery.

2.3.7.2 Alcohol use

Alcohol use post-surgery is still a fairly new research area, but the results indicate that the consumption of alcohol decreases, and the risk of alcohol use disorder does not increase during the first year after surgery. However, during the following years, the risk seems to increase [108, 131, 132]. There also seems to be an increased risk to develop an alcohol use disorder after RYGB and SG compared to other bariatric procedures [108]. It seems especially common after RYGB [131, 133, 134], maybe because SG is still a new procedure with not so many long-term follow-up studies that measures alcohol use. A review and meta-analysis from 2018 [135] showed that there was no risk to develop an alcohol use disorder during the first two years after RYGB, but thereafter the risk increased [135]. A recent review by Ivezaj et al. from 2019 [134] concluded that some predictors of developing an alcohol use disorder post-surgery were being male, younger age, pre-surgical alcohol use disorder, regular alcohol consumption and a lower sense of belonging. To estimate the prevalence of alcohol use disorder after bariatric surgery is difficult, as studies are using different methods. Thus, the prevalence of alcohol use disorder (defined as misuse, abuse or dependence) from the 16 included studies in the review by Ivezaj et al. [134] showed a variation between 1.3% - 28.8%.

To conclude, there might be an elevated risk to develop an alcohol use disorder post-surgery, and healthcare workers should therefore be aware of this risk.

2.3.7.3 Stigma and discrimination

Before surgery, bariatric patients experiences stigma and discrimination because of their overweight and obesity [2, 30]. After bariatric surgery, they are instead stigmatized and discriminated for having “cheated” their way to weight loss, by using a “quick fix”, i.e. bariatric surgery [136].

2.4 PREVIOUS INTERVENTIONS TO IMPROVE PHYSICAL ACTIVITY AND PSYCHOSOCIAL OUTCOMES AFTER BARIATRIC SURGERY

A recent meta-analysis by Ren et al. [68] on RCTs, investigated if exercise interventions could improve weight loss or physical function compared to standard post-surgery care. They found greater weight loss and lower systolic blood pressure and resting heart rate in the patients who attended exercise interventions. Interventions that started at one year after surgery as well as included both aerobic and resistance training also experienced greater weight loss [68]. A review by Hansen et al. [137] concluded that interventions on physical activity and exercise post-surgery could increase BMI loss, muscle strength and physical fitness [137]. Contrary, another systematic review and meta-analysis by Carretero-Ruiz et al. [138] did not find any association between exercise and greater weight loss, but they did not measure the loss of fat mass, only the weight lost [138]. King et al. [139] concluded in a review that if bariatric patients got individualized physical activity counseling post-surgery, they may increase their physical activity levels [139].

Stolberg et al. [80] conducted a randomized controlled trial (RCT) to investigate if supervised exercise post-RYGB could improve both physical activity levels as well as HRQoL. They found small improvements in the intervention group in LPA, MVPA and step counts at one-year post-RYGB, but improvements were not maintained at a two-years follow-up. Two domains of HRQoL: “general health” and “role physical”, improved more in the intervention group at one year, but only “general health” was maintained at the two-year follow-up [80].

There are few interventions studies conducted that aim to improve HRQoL or other psychosocial outcomes and which do not have weight loss as a main outcome [140-144]. Some of the different types of post-surgery interventions conducted that has shown positive results are for example cognitive-behavioral mindfulness [140], psychoeducational group intervention [142, 143] and acceptance and commitment therapy [141]. Improvements were seen in eating behaviors [140, 141], HRQoL [141], self-perceived body dissatisfaction [141], self-efficacy [143] and depressive disorders [140, 142, 143]. A pre-surgery exercise intervention also showed improvements in pre-surgery HRQoL [144].

A recent systematic review on psychosocial interventions both pre- and post-bariatric surgery included 44 studies conducted between 1991-2019 [145]. Majority (33/44) of the included studies measured weight loss, 27 measured eating disorders (e.g. binge eating) and eating behaviors (e.g. emotional eating), eight studies measured lifestyle behaviors (like physical activity) and 14 studies measured HRQoL. They found that psychosocial interventions, and especially cognitive behavioral therapy, improved HRQoL, eating behaviors, depression and anxiety post-bariatric surgery. However, there were weak or mixed evidence on weight loss and physical activity. The optimal time to initiate such interventions seemed to be post-surgery, preferably early after surgery but before any potential weight regain or start of problematic eating behaviors. The authors proposed that future research should focus on effective psychosocial interventions that are able to improve long-term psychosocial outcomes (post-bariatric surgery [145]).

An interview study with bariatric patients revealed that psychological support post-surgery, especially during the first post-surgery year, from healthcare personnel was needed, but often overlooked [20].

In conclusion, exercise interventions post-surgery can increase BMI loss and muscle strength, and some types of interventions seems to improve eating behaviors, body dissatisfaction and HRQoL, and post-surgery seems to be the optimal time to conduct such interventions.

2.5 DISSONANCE-BASED INTERVENTIONS

According to cognitive dissonance theory, people experience a sense of discomfort (dissonance) if they perceive a discrepancy between their cognitions/attitudes and behaviors. To reduce this dissonance, one must change either cognitions/attitudes or behaviors [146]. People are generally motivated to align their attitudes with their publicly displayed behavior to reduce the dissonance caused by public discussion of the negative consequences of specific behaviors they engage in, despite long-term negative outcomes [147]. For example, if a sedentary person is given a chance to publicly criticize a sedentary lifestyle, she will experience dissonance. To remove the dissonance, she will be motivated to exercise to align her attitudes and behaviors. This theory was developed in 1957 by Festinger [146].

Dissonance-based interventions (DBIs) are built on this theory and have been used in several health behavioral interventions [148]. Stice et al. have developed a dissonance-based group intervention that is called “the Body project”, which targets young women with the aim to prevent eating disorders [149-153]. Stice et al. has also developed the project “Healthy weight” to prevent weight regain [154]. These interventions include four group sessions and have proven to be successful in the prevention of eating disorders, unhealthy weight gain and decreased body dissatisfaction, when compared to control groups, and with sustained effect long-term [154]. Stice et al. later developed “Project health” by adding dissonance-based activities to the “healthy weight” project, which resulted in larger effect for preventing weight gain [155]. “The body project” has been implemented in large-scale and been conducted by other research groups globally [151].

Other DBIs on preventing eating disorders have also shown positive results, compared to other programs based on other theories, to prevent eating disorders which have shown limited efficacy [149]. DBI also showed greater effects compared to a supportive mindfulness group treatment [156]. A meta-analytic review of DBIs on the prevention of eating disorders and body dissatisfaction, showed that the intervention effects were larger the more dissonance-inducing activities, group sessions and larger group sizes. Also, the effects were larger the more training a facilitator had and when the intervention was delivered in-person versus online [147]. DBIs have also shown effects in various other health behaviors, such as to promote physical activity behaviors [157] and prevention of smoking cessation [149].

Stice et al. recently published a RCT study [158] that investigated if “the Body Project” could still be effective whether it was clinician-led, peer-led or internet-based, and compared to an educational video control group. The results showed that the peer-led groups had larger

reductions than the internet-based groups in some of the risk factors and eating disorder onset over four-years follow-up were lower for the peer-led groups. However, all group-formats had larger decreases in eating disorder symptoms and risk factors at two years-follow-up, with some of the effects still present at four-years follow-up, compared to the control group [158].

In conclusion, DBIs have proven to be short but rather effective interventions for various health behaviors [149].

However, DBIs have never, to our knowledge, been conducted with the aim to maintain as well as prevent the decline in HRQoL, eating behavior, body esteem and social adjustment, and hopefully increase physical activity, in bariatric surgery patients. As bariatric surgery patients lack psychosocial support from the health care, a DBI was developed by the research group that, if proven effective, easily could be implemented in the health care setting. This intervention will be described in more detail below.

3 AIMS

The overall aim of this thesis was to investigate if a dissonance-based intervention study could prevent a decline in HRQoL and improve eating behavior, body esteem, social adjustment and physical activity in women after RYGB surgery. Additional aims were to compare the differences in self-reported and objectively measured physical activity in women before and after RYGB, as well as to explore RYGB-treated women's' long-term perceptions of physical activity.

The specific aims were:

- I. To investigate the effects of a dissonance-based group intervention in a RCT with HRQoL as main outcome, and eating behavior, body esteem and social adjustment as secondary outcomes, in women two years post-RYGB surgery.
- II. To investigate if this dissonance-based group intervention has beneficial effects on physical activity in women two years post-RYGB surgery.
- III. To investigate how the duration of MVPA (main outcome) and other intensities of physical activity differ when assessed by a self-administered questionnaire and by an accelerometer at pre- and up to 48 months post-RYGB, in women undergoing RYGB-surgery.
- IV. To qualitatively explore women's' perceptions and experiences of physical activity five years after RYGB surgery.

4 METHODOLOGICAL CONSIDERATIONS

4.1 OVERVIEW

This thesis consists of two different study groups with their own data collections. Study I and Study II belong to the first one, which is a RCT that includes an intervention called WELL-RYGB (Wellbeing after RYGB, in Swedish VÄLG, Välbefinnande efter Gastric Bypass). Study III and Study IV belong to the second data collection, which is a longitudinal cohort study comprising both quantitative (Study III) and qualitative (Study IV) methods. Figure 2 shows an overview of the four studies.

4.2 STUDIES I - II: THE WELL-GBP TRIAL

The WELL-GBP trial is a randomized dissonance-based intervention study that target RYGB-treated women, with the overall aim to optimize and prevent a decline in various wellbeing-related outcomes. Study I investigated the intervention effects on HRQoL (main outcome), eating behavior, body esteem and social adjustment two years post-RYGB, and Study II investigated the effects on physical activity. The WELL-GBP has been registered as a trial (ISRCTN16417174) [159], approved by the Stockholm Ethical Review Board (registration number: 2013/1847-31/2) and all participants gave written informed consent before entering the study.

4.2.1 Recruitment and data collection

Women eligible for RYGB surgery ($\text{BMI} \geq 40 \text{ kg/m}^2$, or if comorbidities were present a $\text{BMI} \geq 35 \text{ kg/m}^2$), who had not previously undergone any bariatric surgery and were able to understand and speak Swedish, were invited to participate between January 2015 to June 2017 from five Swedish hospitals (Danderyd Hospital, Ersta Hospital, S:t Görans Hospital, Uppsala University Hospital and Örebro University Hospital). At the time of recruitment, these hospitals accounted for approximately 25% of all performed bariatric surgery procedures in Sweden [160]. Recruitment were done at the hospitals during their pre-surgery information meetings by either a nurse, dietician or surgeon working with RYGB patients, or by one of the researchers working with the data collection. These meetings were held weekly or monthly depending on the hospital, usually between one to three months prior to surgery. Women who were interested in the intervention filled in a declaration of interest form ($n = 600$), and were then contacted over the telephone by a researcher who gave additional information. At this point, some of the women didn't know what type of bariatric surgery they were going to have (SG or RYGB) but received information that only RYGB-patients would be included in the study. If they wanted to participate, they received a consent form, questionnaires and an accelerometer (see chapter "*Methodological considerations - Measurements and outcomes*") that were sent to their homes by mail, together with a prepaid envelope to return the data materials. A woman was considered as included in the intervention when she had returned the consent form with the completed questionnaires and if she had RYGB surgery ($n = 259$).

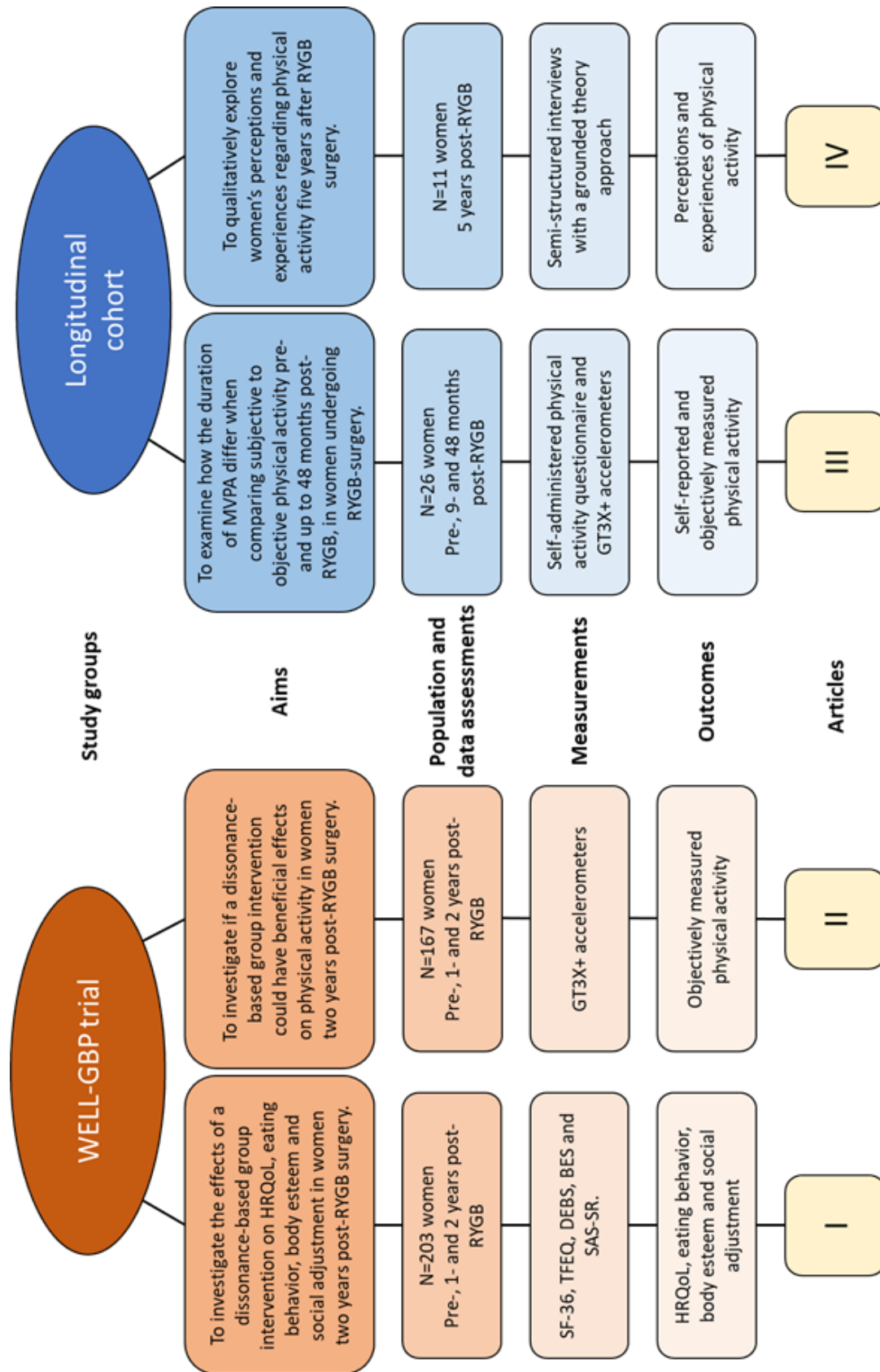


Figure 2. Overview of the four studies and its data collections, that are included in the two study groups.

Follow-up assessments were done at six months (not included in this thesis), one-, and two years post RYGB-surgery. Figure 3 shows a timeline of the WELL-GBP trial, and Figure 4 shows a flow-chart of the recruitment and the follow-up assessments of the intervention study. The flow-chart only includes follow-up information about the participants with valid questionnaires that were included in Study I. For a flow-chart of the participants with valid accelerometer measurements that were included in Study II, see Figure 1 in Article II. As a thank you for participating in the study, the participants received a cinema ticket or a voucher worth 100 Swedish kronor, as well as feedback from their accelerometer data (if they wore one), for each completed assessment. A detailed study-protocol of the intervention has been published elsewhere [161]. Results from one-year follow-up of the WELL-GBP intervention has previously been reported [162] and is included in another PhD thesis, as well as an article about associations between HRQoL and meeting the physical activity recommendations in the control group [71].

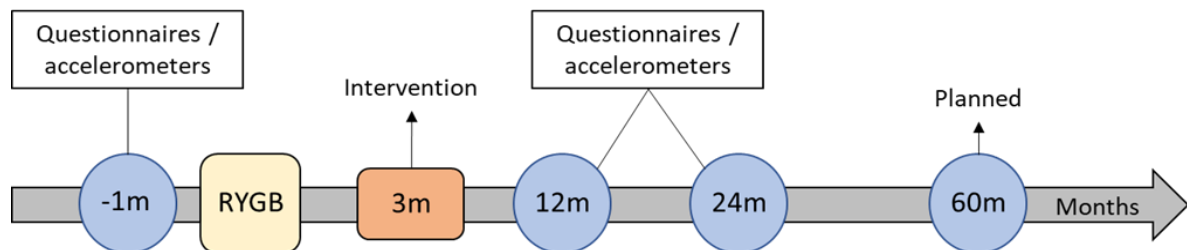


Figure 3. Timeline for the WELL-GBP trial with its three data assessments. For each assessment, weight and height were measured at the patient's hospital. The five-year follow-up is planned to start in 2020.

4.2.2 The WELL-GBP intervention

The intervention was delivered approximately three months post-RYGB and consisted of four group sessions, conducted once a week for four weeks. The group sessions were held at Ersta Hospital, Uppsala University Hospital or Örebro University Hospital, and participants attended the sessions in the city where they had had their surgery. A session lasted around 1.5 hours. Dates and times for each of the sessions were decided in agreement with the participants. The intervention was based on Stice et al. dissonance-based group intervention “the Body project” for preventing eating disorders [149, 150]. The intervention was modified to suit RYGB patients and a facilitator, trained in dissonance-based theory, led the sessions by following a written intervention manual. All sessions were videotaped (only the facilitator appeared on camera) in order to ensure a consistent and systematic delivery of the intervention. The training of the facilitators consisted of meeting with a psychologist (Ata Ghaderi (AG)), who has great knowledge about dissonance-based theory and gave information about the essentials about theory, individual readings on the topic, as well as to review some of the videotaped sessions together with AG.

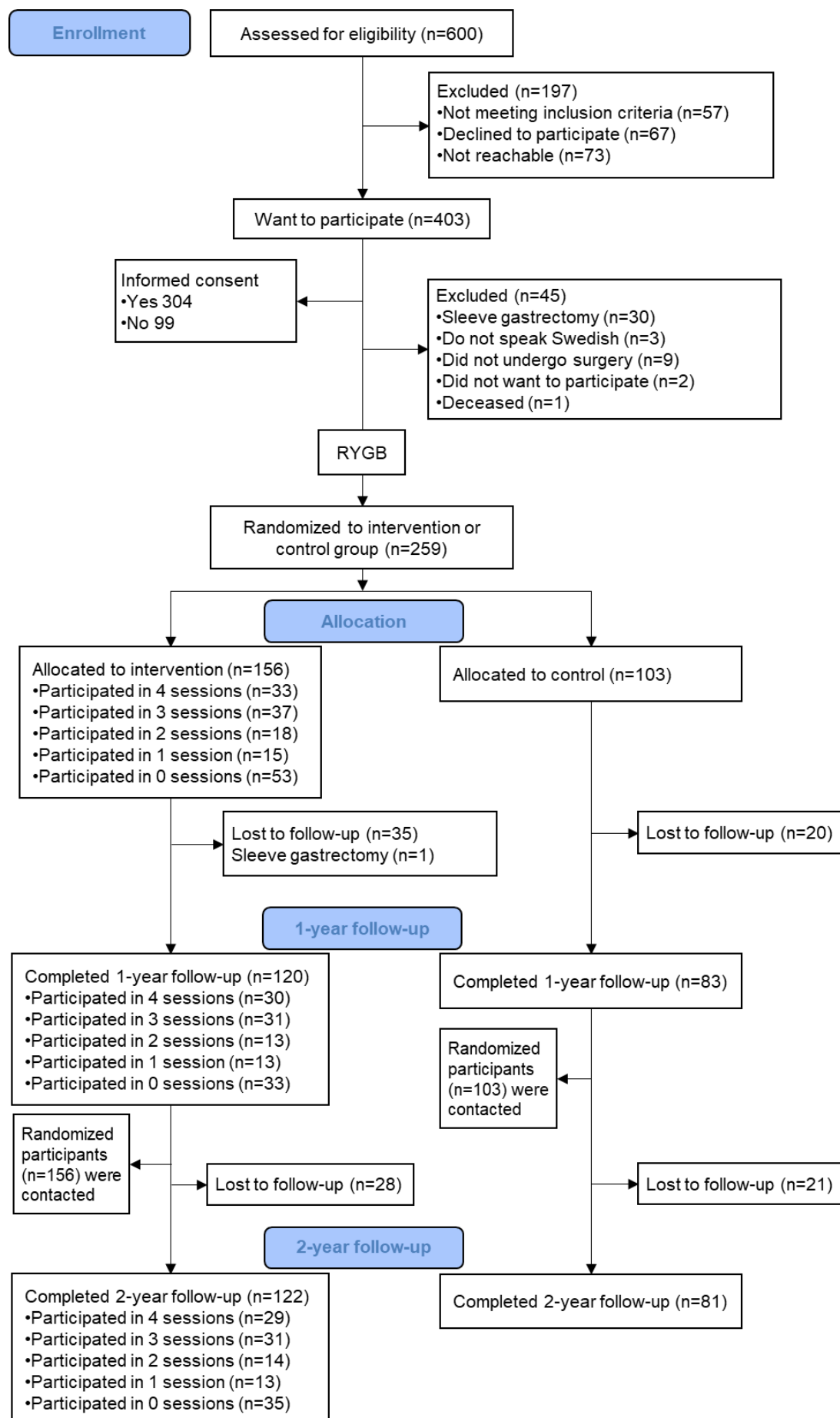


Figure 4. Participant flow-chart of the WELL-GBP trial, according to CONSORT standards.

The manual was developed in 2015 by researchers (Mikaela Willmer (MW), AG, Finn Rasmussen (FR) and Fanny Sellberg (FS)) who were included in the development of the intervention, and it was based on previous literature and experiences on common difficulties after surgery [163]. Each session focused on a specific topic known to be problematic or difficult following RYGB surgery: (i) physical activity (ii) eating behavior, (iii) social relationships and (iv) intimate relationships. A participant was considered having received the intervention according to protocol if she had attended at least three of the four sessions.

The purpose of the intervention was to provide the participants with coping strategies for possible future difficulties within each topic. This was achieved by having group discussions on how to handle future challenges in order to optimize their health and quality of life, and how to think and act so that the positive benefits from the surgery maintained. Some parts of the manual specifically encouraged discussions that were meant to induce dissonance and increase the possibility of healthy actions and attitudes. Each session included discussions on different issues within each topic, discussions around fictional scenarios based on previous RYGB-patients' experiences and quizzes. Between each session, the participants had a home exercise, related to the previous topic, where they were supposed to write down different goals or attitudes, how they would be achieved, identify possible obstacles they expected to encounter or how they wanted to tackle specific future challenges.

4.2.2.1 Randomization

Approximately two months after RYGB, before the intervention started, participants were randomized to either intervention (60%, $n = 156$) or control group (40%, $n = 103$). The SAS 9.4 procedure Proc Plan (SAS Institute Inc., Cary, NC, USA) was used to randomize participants in blocks of five, separated by their counties, with the random allocation sequence computer generated into 60% intervention and 40% control. The randomization of participants was performed by an investigator not involved with the data collection. Blinding of participants or investigators was not possible. Both intervention and control groups received the standard follow-up care provided by the hospitals.

4.2.2.2 Power calculation

Initial power calculations (calculated to detect any differences in HRQoL between the groups) estimated that in order to achieve a statistical power of 0.90 and a significance level of 5% with an expected moderate effects size (Cohen's $d = 0.5$), and with an expected drop-out rate of 20%, a sample size of 240 participants needed to be recruited [161]. In total, 259 participants were included after recruitment, where 203 of the participants (intervention group $n = 122$, control group $n = 81$) had complete baseline and two-year follow-up data, providing a statistical power of more than 90% to detect the planned effect size.

4.3 STUDY III: THE LONGITUDINAL COHORT STUDY

Study III is based on an already existing longitudinal cohort study of RYGB-treated women. Results from the cohort has been included in three previous PhD theses with several

published articles [18, 72, 73, 164-168]. Initial aim of the cohort was to investigate if RYGB surgery among mothers had any effect on physical activity and other aspects of wellbeing in the mothers' children and spouses. Study III only includes the mothers from the cohort and focuses on the physical activity measurements. This study was approved by the Stockholm Ethical Review Board (registration number: 2009/1472-31/3) and all women have given written informed consent.

4.3.1 Recruitment and data collection

Recruitment of women started in April 2011 from recruiting lists from the same five hospitals as in Study I and Study II. Inclusion criteria were to be eligible for RYGB surgery, having a child between seven and 14 years old and able to speak Swedish. In total, 69 women were recruited at baseline who had RYGB surgery between June 2012 and January 2013. Data was collected by home visits by researchers at three months pre-RYGB and nine-months post-RYGB (done by Daniel Berglind (DB)) as well as 48 months post-RYGB (done by FS). During the home visits, the researchers measured the women's weight and height and delivered a self-administered questionnaire on, among others, self-estimated physical activity, together with an accelerometer (ActiGraph GT3X+) that the women should wear for seven consecutive days (see chapter "*Methodological considerations - Measurements and outcomes*"). The data material was, after completion, sent back to the researchers by mail. Previously, an article has been published that investigated the discrepancies between self-reported physical activity to accelerometer measurements from the nine-month follow-up [18]. It included 43 of the 69 women (62%) who had complete and valid data at the pre- and nine-months assessments from both the questionnaire and the accelerometer. Study III also looks at these discrepancies but focuses on the 48-month follow-up. Figure 5 shows a timeline of the data assessments for Study III and Study IV.

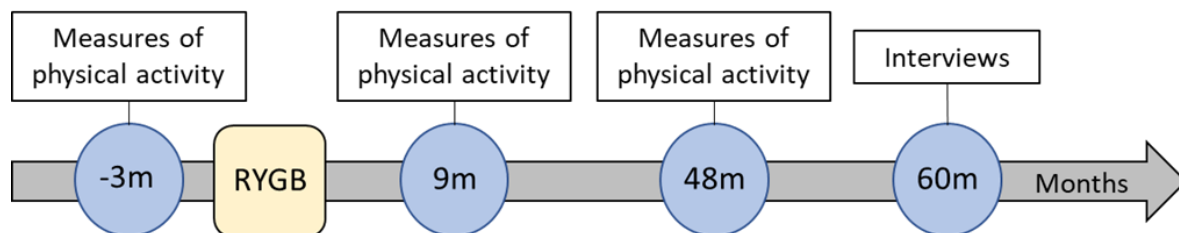


Figure 5. Timeline for the longitudinal cohort study. The first three data assessments include the subjective and objective physical activity measurements, and the fourth is the qualitative interviews.

4.4 STUDY IV: THE INTERVIEW STUDY

Study IV is a qualitative interview study and includes some of the women that belongs to the cohort described above in Study III. As mentioned before, previous results from this cohort has shown that women overestimate their levels of physical activity to a much greater extent nine months after RYGB, compared to before surgery [18]. However, the reasons why women overestimated their physical activity is unknown and the knowledge of physical

activity among patients who have undergone bariatric surgery in a long-term perspective is scant. Consequently, an interview study was designed with a grounded theory (GT) approach, inspired by Corbin & Strauss [169]. GT was chosen in order to get a deeper understanding of the processes and underlying factors of performing (or not performing) physical activity after RYGB, and with a GT approach, an explanatory model could be developed to explain the findings. This interview study was approved by the Stockholm Ethical Review Board (registration number: 2016/836–32) and all participants gave written informed consent prior to the interviews.

4.4.1 Recruitment and data collection

The recruitment of the women for Study IV started in March 2017 and included women (n = 38) who had participated in the 48-months follow-up (Study III). They were contacted by mail with an information letter about the interview study and an invitation to participate, together with an informed consent and a prepaid envelope to send back the consent. Approximately four weeks apart, subsequent reminders were sent out twice with the same information as in the first letter. When an informed consent was returned, the participant was regarded as included and were contacted by telephone by a researcher (Sofie Possmark (SP)), to provide additional information, if asked for, and to decide a time and place for the interview. In total, 14 informed consents were received. Despite the informed consents, one woman decided to drop-out as she was in the middle of a move abroad and two women never answered the phone calls, which resulted in 11 eligible interview participants.

An interview guide based on previous research findings about physical activity after RYGB was developed by researchers in the research group (SP, Margareta Persson (MP) and DB). In total, the interview guide included three central topics: HRQoL, experiences of the post-surgery care provided by the hospitals and physical activity. In this thesis, only parts that concern physical activity was included and analyzed. The topic guide that covered physical activity can be seen in Table 1.

The interviews were conducted between April 2017 and March 2018, and the locations of the interviews were all chosen by the participants. Eight interviews were held in the participants' homes, two were held in one of the researcher's (SP) office and one was held over the telephone, as it proved to be difficult to find a date and place for a face-to-face meeting. The interviews were between 36 – 120 minutes long. During the interviews, the height, weight and waist circumference of the participants were measured by the interviewer, but it was not possible to measure the woman who did the interview over the telephone. However, the woman had earlier the same day been to her five-year standard follow-up at the hospital where she had her surgery, so she reported her hospital measured weight. All interviews were audio recorded after permission from the participants.

Table 1. Main topics of the interview guide that regarded physical activity (PA).

Main topics asked during interview
<ul style="list-style-type: none"> - What is PA for you? - How do you perceive yourself when it comes to PA and exercise? - During the last month, how would you describe your PA? - What obstacles do you perceive you have in order to achieve a good (for you) level of PA and/or exercise? - What is your knowledge about PA? If any knowledge, where did you acquire it? - What are your thoughts about exercise and weight loss, compared to exercise and wellbeing? - Do you have any support to be active? - Do you have problems with loose skin after surgery, and if so, have it been bothering you during PA or exercise? - What advice about PA and exercise would you give to someone who were about to undergo a RYGB-surgery?

As a part of the GT approach, an emergent design was applied during the interview process, meaning that the interview guide could be updated between interviews if new interesting and probing questions came up during the previous interview that needed some further exploration. Also, memos were written immediately after each interview that included overall reflections and impressions from the interview, as well as new ideas or questions that needed to be considered to the interview guide and primary analysis.

All interviews were conducted by the same researcher (SP), except for the first interview where also an experienced qualitative researcher (MP) was present. The plan was to interview women until saturation of data was obtained and to start with the 11 women who had sent in their consent form. If saturation had not been reached after finishing the 11 interviews, more women had been recruited from the cohort. But it was found not necessary, as the last three interviews did not reveal any new major findings, thus indicated that saturation had been reached.

4.5 MEASUREMENTS AND OUTCOMES

4.5.1 Questionnaires

Below follows a detailed description of the five questionnaires used to measure the outcomes in Study I (HRQoL, eating behavior, body esteem and social adjustment) and the physical

activity questionnaire used in Study III. In addition, there were also some background questions included in all studies about participant characteristics, such as general health condition, long-term sickness, prevalence of diabetes, tobacco and alcohol use, type of employment, highest level of education and work- and living conditions.

SF-36

Main outcome in Study I was HRQoL, measured by the 36-item Short Form Health Survey (SF-36). This instrument is a common tool to measure HRQoL before and after bariatric surgery [92] and has shown high internal consistency and good construct validity [170]; also after being translated to Swedish [171, 172]. It has shown to be a stable instrument among healthy populations [173], and has acceptable validity among people with severe obesity [174].

SF-36 comprises eight dimensions of HRQoL: (i) physical functioning, (ii) role limitations due to physical health problems, (iii) bodily pain, (iv) general health, (v) vitality, (vi) social functioning, (vii) role limitations due to emotional problems and (viii) mental health. These dimensions are divided into two summary scores: a mental component summary score (MCS) and a physical component summary score (PCS). Each question has a raw score, which are transformed into a scale from 0 (worst possible HRQoL) to 100 (best possible HRQoL). Examples of questions are: “During the last four weeks, how much of the time have you felt gloomy and sad?” scoring from 1 (all the time) to 5 (none of the time) and “How much bodily pain have you experienced during the last four weeks?” scoring from 1 (none) to 6 (very severe).

TFEQ

Eating behavior was measured using the Three-Factor Eating Questionnaire (TFEQ), which is a questionnaire for measuring cognitive and behavioral components of eating. It has been tested and shown to have good reliability in people with obesity and non-obesity [175], and has shown acceptable validity in a Swedish sample of people with obesity [176]. It has previously been used to measure eating behavior before and/or after bariatric surgery [165, 168, 177-179].

TFEQ has 21 items and comprises three domains: (i) cognitive restraint (TFEQ-CR), (ii) emotional eating (TFEQ-EE) and (iii) uncontrolled eating (TFEQ-UE), as well as a total summary score. Scoring is done on a four-point likert-type scale, where lower scores indicate better eating behavior. Examples of questions are: “I consciously hold back during meals so as not to gain weight” (TFEQ-CR); “When I am feeling alone I comfort myself by eating” (TFEQ-EE); and “Sometimes when I start to eat I just can’t seem to stop” (TFEQ-UE).

DEBS

Besides TFEQ, the Disordered Eating after Bariatric Surgery (DEBS) questionnaire was also used to measure post-surgery eating behavior in all follow-up assessments. DEBS is a

questionnaire that specifically measures disordered eating after bariatric surgery during the last 28 days. It has shown good reliability, validity, internal consistency and test–retest reliability [180].

DEBS includes seven items, where in the first three items the respondent state how many of the last 28 days she has been eating although feeling that the stomach was full, frequently snacking more than recommended throughout the day and eating a too large amount of food in a too short time-frame than is normal given the new size of the stomach. In the remaining four items, the respondent will state in how many of the incidences from the first three questions she has lost control over her eating, experienced shame associated to her eating, vomiting and been eating in secrecy. Lower scores indicate a lower rate of disordered eating. This questionnaire has an open question format, which resulted in that some patients replied with words, i.e. “sometimes” or “often” instead of number of days. Therefore, a manual was developed on how to score from text, in order to achieve consistency when interpreting these kinds of answers. Each questionnaire was then double-checked and recoded if any inaccuracy were detected.

BES

Body esteem was measured with the Body Esteem Scale (BES). Originally, this questionnaire was designed for children (24 items with “yes or no” answers) [181], but has later been developed to suit adults and adolescents, with a high internal consistency and test-retest reliability [182]. In Study I, a Swedish translation of BES was used [183].

BES has 21 items and comprises three subscales: (i) Appearance (BES-APP), measuring general feelings about appearance, (ii) Weight (BES-W), measuring weight satisfaction and (iii) Attribution (BES-ATT), measuring evaluations attributed to others about one’s body and appearance. It is a five-point likert-scale type and the respondents rated their agreement with each statement, ranging from 0 (= never) to 4 (= always), where higher scores indicate healthier body esteem. Examples of statements for each subscale are: “I like what I see when I look in the mirror” (BES-APP); “I’m satisfied with my weight” (BES-W); and “My friends like my appearance” (BES-ATT).

SAS-SR

Social adjustment was measured by the Social Adjustment Scale – Self Reported (SAS-SR). The questionnaire derives from an interview tool, but has been developed into a self-reported questionnaire [184]. It has a wide applicability in a broad range of subjects [185]. A version modified to a British population (from an American population) was used in Study I [186], and then translated to Swedish.

SAS-SR is a 45-item scale, comprising six domains: (i) work role, (ii) social and leisure activities, (iii) relationships with extended family, (iv) parental role, (v) role as marital partner and (vi) role within the family unit. It is a five-point scale, where lower scores indicate higher social adjustment. Examples of questions are: Over the last two weeks, have you...: “...Felt

upset, worried or uncomfortable at work?“, “...Been offended or had your feelings hurt by your friends?” and “...Been able to talk about your feelings and problems with your partner?”.

Physical activity

In Study III, a short self-administered physical activity questionnaire was used to measure subjective physical activity. The questionnaire aims to measure long-term total daily 24-hour physical activity. It has been validated against accelerometers in women with reasonable validity [187] and against seven-day physical activity diary in men with a satisfactory estimate [188].

The questionnaire has five predefined activity domains, and the participants self-assessed their average time spent in the different domains during the previous week. Three domains have six response options, these domains are: work/occupation (“mostly sitting down at work” to “heavy labor”), household work (“less than 1 h/day” to “more than 8 h/day”), and walking/cycling (“hardly ever” to “more than 1.5 h/day”). Two of the domains have five response options: TV/reading, which is defined as leisure time inactivity (“less than 1 h/day” to “more than 6 h/day”) and exercise, which is defined as leisure activity time (“less than 1 h/week” to “more than 5 h/week”). In addition, there is an open question concerning number of sleeping hours per day.

4.5.2 Accelerometers

In order to objectively measure physical activity levels in Study II and Study III, ActiGraph GT3X+ accelerometers (ActiGraph, Pensacola, USA) were used in both the intervention study (Study II) and in the cohort study (Study III). It uses a tri-axial movement to measure physical activity and has shown to be a valid tool for estimating physical activity with good accuracy [189]. All participants in Study II and Study III were encouraged to wear the accelerometer on the right hip during all waking hours for seven consecutive days at pre-RYGB and at all follow-ups. An accelerometer measurement was counted as valid if wear time had a minimum of at least 10 hours per day for at least three days [190].

Three-dimensional vector magnitude (V_m) activity counts (calculated as the square root of the sum of the counts of the three axes) was recorded and analyzed in 10-second epochs and then converted to counts per minute (cpm). An algorithm by Choi et al. [191] was used to classify wear time, where non-wear time was set to at least 60 minutes of no counts with a maximum of two minutes of non-zero interruptions. Non-wear time was then removed from the analysis. Classification of the cut-offs for the different physical activity intensities were based on Santos-Lozano et al. [192]: sedentary time was classified as <100 cpm, light physical activity (LPA) as 100-3208 cpm, and MVPA >3208 cpm. For Study II, wear time and classification of bouts were calculated with the use of ActiLife v.6.13.3 (ActiGraph, Pensacola, USA), and for Study III the R-packages “Accelerometry” and “Physical Activity” (<https://cran.r-project.org>) were used.

The definition of the physical activity recommendations that was used in Study II and Study III comes from WHO, who recommends a minimum of at least 150 minutes per week of MVPA [55, 57], which is also stated in the second edition of the “Physical Activity Guidelines for Americans” [56].

4.6 DATA ANALYSIS

BMI was calculated as weight (kg)/height (m)² for all studies included in this thesis.

Study I and Study II has a RCT design, which enables to compare the intervention to the Swedish standard follow-up care that is provided by the hospitals. With the RCT design, the groups should not differ at baseline, and therefore focus of these articles are on the differences of the outcomes at the two-year follow-up. For Study I, participants who had complete questionnaire data at baseline and the two-years follow-up were included in the analyzes, as some women dropped-out during the follow-up assessments. For Study II, the women who had complete accelerometer data at the two-years follow-up were included only, as not all women had had time to wear an accelerometer prior to their surgery, which resulted in fewer measurements at baseline than in the follow-ups. Primary analyzes for these studies were intention-to-treat (ITT) analysis. Because some women in the intervention group did not attend all group sessions (but still provided questionnaire and accelerometer data for the follow-ups), per-protocol (PP) analyzes were conducted between the women in the intervention group who received the intervention according to protocol (attended ≥ 3 group sessions) and control group.

Study III has a longitudinal design, including repeated measures within the same subjects, which enable controlling for factors that are constant, such as various personal characteristics. Only the women in the analyzes who had complete questionnaire data and valid accelerometer measurements at all three data assessments (pre-RYGB, nine- and 48-months follow-up) were included. Primary analysis for this study was to compare differences between means in subjective to objective physical activity data 48 months post-RYGB. Correlation statistics were also performed to see if there were any correlations between the subjective and objective measurements. All statistical analyzes for Study I and Study III were conducted using Stata 14.1 (StataCorp) software.

Study IV was a qualitative interview study with 11 women that followed the analysis procedure of GT that is described by Corbin & Strauss [169].

4.6.1 Studies I - II (statistical analysis)

The majority of all variables, both questionnaire and accelerometer outcomes, were non-normally distributed, and therefore Kruskal-Wallis H-test was used when testing for any differences in means between the intervention and control groups, ITT analyzes as well as PP analyzes. Chi-square test was performed for dichotomous variables. Effect sizes of the intervention was calculated as Cohen’s *d* [193], to be able to interpret and compare the two groups.

For Study I, sensitivity analyzes were also performed between women in the intervention group who had attended 3-4 sessions, 1-2 sessions or zero sessions with One-way Anova and additional post hoc test (Tukey). In Study I, missing data on a specific question excluded the participant from the analysis of that outcome but were included in the rest of the analyzes.

For Study II, as additional analyzes of the ITT analysis, all outcomes at the two-year follow-up were adjusted for wear time. Because there were no great differences in wear time between intervention and control group at the two-year follow-up, adjustments for wear-time was not done in the primary ITT analysis. Moreover, sensitivity analyzes were calculated for the participants who had valid accelerometer measurements from all pre- and post- data assessments, performed with a regression analysis adjusted for baseline measures. It was presented as differences in means between the groups at the one- and two-years follow-up. Additional sensitivity analyzes was also conducted among the participants who had valid accelerometer measurements at the two-year follow-up for more than five days.

4.6.2 Study III (statistical analysis)

Study III includes measurements from both self-reported data and accelerometer data. To be able to compare those, the responses in the self-administered questionnaire were converted into mean minutes per day spent in each domain of physical activity. To obtain an outcome of self-reported MVPA, the two domains “walking/biking” (active leisure time) and “exercise” were combined. The domain “work/occupation” did not have any time response options. Therefore, to obtain a self-reported occupational sedentary outcome, the response options “mostly sitting down” and “sitting down half the time” were merged. To obtain an occupational outcome that included more physical activity, the response options “mostly standing up”, “mostly walking, lifts, carry little”, “mostly walking, lifts, carry a lot” and “heavy manual labor” were combined. Thereafter, the prevalence of sedentary or physically challenging work/occupation were calculated.

T-tests were used to calculate the differences in means between baseline, nine-months and the 48-months follow-up for the descriptive characteristics, the accelerometer measurements and the outcomes from the self-administered questionnaires. The majority of all variables were non-normally distributed. Therefore, the mean differences between the three data assessments were presented with non-parametric 95% bias-corrected and accelerated bootstrap (BCa) confidence interval (instead of standard deviation (SD)). The *p*-values were calculated with Wilcoxon Signed-Rank test. Correlations between the questionnaire and the accelerometer measurements were performed by using Spearman’s rank correlation. To visualize the results, Bland-Altman plots and scatterplots were conducted.

In addition, sensitivity analyzes were conducted that compared the included women (*n* = 26) to the women in the original cohort that were not included (*n* = 43) for baseline characteristics and physical activity outcomes. Finally, sensitivity analyzes were also performed for the women who had complete questionnaire data and wore the accelerometer during at least 12 hours per day for more than five days, at all three data assessments.

4.6.3 Study IV (qualitative data analysis)

Because a GT approach inspired by Corbin & Strauss [169] was used with an emerging design, the data collection (the interviews) and the data analysis were a parallel process. It meant that immediately after the interview was conducted, a primary analysis of that interview started. This process made the development of concepts and categories that were later used to deepen and enhancing the following data collection, by updating the interview guide with the new questions that emerged.

After each interview was conducted, it was transcribed verbatim by the interviewer (SP) or a research assistant, and thereafter the whole transcript was coded. A preliminary analysis was performed at this stage to see if the interview guide needed any adjustments before next interview was planned. The codes that concerned the topic of physical activity were identified, which resulted in a total of over 600 codes. Parts of the initial coding was performed in collaboration with MP, first individually and then a comparison was made. Then, the codes that were similar to each other were assembled and created properties. Related properties were then assembled and created more overall categories. Lastly, a core-category emerged that symbolized the similarities and differences of all the data materials. Throughout this process, the memos were used to make sure that no ideas about the data were lost and to secure that the emerging findings were grounded in the data. Finally, in order to explain the processes regarding physical activity, an explanatory model based on the findings was developed. This process of analysis followed the steps by Corbin & Strauss [169].

The analysis was mainly done by one of the researchers (SP), but in close collaboration and discussion with MP and the other co-authors, to minimize the risk of bias, misinterpretation or invention of data.

4.7 ETHICAL CONSIDERATIONS

The Stockholm Ethical Review Board approved of all studies included in this thesis, written and oral informed consent was obtained from all participants, and the interviews in Study IV were audio recorded after permission from the participants. The intervention study (Study I and Study II) did not involve any medical procedure. All data materials that were collected have been stored anonymously according to regulations and guidelines of Karolinska Institutet and all data are published anonymously. Nevertheless, some ethical aspects need to be considered.

General for all studies is that it is essential to be aware of the fact that people with severe obesity and who have had RYGB surgery often are discriminated and stigmatized in the society [2, 136]. Therefore, it was of utmost importance that the research team always approached and treated the participants with respect and non-judgement. All participants received information that they were taking part in the research studies on their free will and that they could withdraw at any time, without any consequences from the researches or the post-surgery healthcare. To measure someone's weight can be sensitive and may not be

approved by all. If a participant didn't want to have her weight measured, her will was respected and that information was not collected.

For Study I and Study II, all participants were women, and during the group sessions in the intervention study, sensitive topics, such as intimate relationships, were discussed. Therefore, all facilitators were women, as these topics can be found even more sensitive if discussed with the opposite sex. The design of the group sessions didn't require the participants to talk about their own intimate and private conditions, because the sessions were built on made-up scenarios to tackle the topics. Therefore, the participants could talk in more general terms, if they did not want to share personal information. The aim of the sessions was to improve HRQoL, and the research group do not think that these group sessions caused any harm. Even so, the possibility that any mental problems, like anxiety or depression, could have occurred when discussing topics like this cannot be excluded. The facilitator therefore had to be aware, and show respect for, if a participant did not want to share any thoughts during these sessions. The same cautions (respect and awareness) applied for Study IV during the interviews. The questionnaires used in Study I also have the possibility to bring up distress, as some questions can be found intimate and sensitive. If any distress would have occurred, the participant could be referred to suitable medical care as there were competence in the research team (i.e. AG is a psychologist). To the research groups knowledge, none of the participants suffered any distress caused by the intervention, the questionnaires or the interviews.

When conducting interviews, as in Study IV, it is always of importance to keep in mind that all topics discussed during an interview have a potential of being sensitive for the person being interviewed [194]. It is therefore crucial to treat each participant with respect and not to judge her experiences, perceptions or opinions, and to be aware of the accompanying risks and biases [194, 195]. However, no distress or indignation during or after the interviews were indicated. We, the research team, believe that our research has more benefits for the participants that by far outweigh any possible caused harm.

5 RESULTS

A summary of the main results of each study are presented below. For more detailed descriptions, see Articles I-IV.

5.1 STUDY I: WELL-GBP AND HEALTH-RELATED QUALITY OF LIFE

In total, 259 participants (intervention $n = 156$, control $n = 103$) provided pre-RYGB measurements. Their mean age pre-RYGB were 44.8 (SD = 10.3) years and they had a pre-RYGB BMI of 40.8 (SD = 4.5) kg/m^2 . Of the 156 participants allocated to intervention group, 103 (66.0%) attended at least one group session, 70 (44.9%) received the intervention according to protocol (attended ≥ 3 group sessions) and 33 (21.2%) attended all four sessions. There were no statistically significant differences in baseline characteristics at pre-RYGB between the intervention and control groups. For more details on the baseline characteristics, see Table 2. At the two-years follow-up, 203 participants (intervention $n = 122$, control $n = 81$) had complete questionnaire data and were included in the two-year analyzes, resulting in a drop-out rate of 21.6% (21.8% in the intervention and 21.4% in the control group). Mean BMI at two-years was 27.0 (SD = 3.8) kg/m^2 for the intervention group and 27.4 (SD = 4.0) kg/m^2 for the control group. Of the participants included in the two-year follow-up, 71% from the intervention group attended at least one group session and 49% received the intervention according to protocol.

Table 2. Baseline (pre-surgery measures) characteristics of total sample, the intervention group and control group of the women undergoing Roux-en-Y Gastric Bypass (RYGB) surgery that are included in the 2-year follow-up.

Variables	Total sample $n=203$	Intervention $n=122$	Control $n=81$	p -value
BMI (kg/m^2) (SD)	40.9 (4.5)	41.0 (4.4)	40.8 (4.6)	0.759
BMI change at 2 years post-surgery (SD)	-13.7 (4.3)	-14.0 (4.4)	-13.4 (4.2)	0.447
% total weight loss (SD)	33.3 (8.7)	33.8 (8.7)	32.5 (8.7)	0.403
% excess BMI loss (excess BMI > 25 kg/m^2) (SD)	88.1 (23.0)	88.7 (22.1)	87.1 (24.6)	0.369
Age at surgery (years) (SD)	44.8 (10.2)	44.1 (10.4)	45.8 (9.8)	0.156
Education, university level (%)	60 (29.7)	36 (29.8)	24 (29.6)	0.985
Smokers (%)	13 (6.4)	6 (4.9)	7 (8.6)	0.289

BMI = body mass index. Presented as mean (standard deviation) or number (percentage).

ITT analysis at the two-years follow-up only showed a difference between the groups in the outcome TFEQ-CR, where the control group had significantly ($p = 0.010$) higher (i.e. poorer eating behavior) at all data assessments. No other outcome differed between the groups and the intervention effects were poor (Cohen's $d = 0.00 - 0.36$) and non-significant for all outcomes. Table 3 shows baseline and two-year outcomes for the total summary scores of all scales and the domain TFEQ-CR. For more detailed data on all the domains and the one-year follow-up, see Table 2 in Article I. Nevertheless, in both groups from baseline to the one-year follow-up, all domains of SF-36, eating behavior, body esteem and social adjustments had improved and were maintained at the two-years follow-up.

PP analysis were done between the participants in the intervention group who had received the intervention and the control group, but no significant differences in any of the outcomes at two years were observed (Appendix 1 in Article I). Sensitivity analyzes were performed between the participants in intervention group that had attended 3-4 group sessions ($n = 60$), 1-2 sessions ($n = 27$) or zero sessions ($n = 35$). The only significant difference from these analyzes was for the domain TFEQ-UE (One-way Anova $p = 0.048$). However, after performing a post hoc test (Tukey), no significant differences were seen (Appendix 2 in Article I). No significant differences in baseline characteristics or any other of the outcomes were observed between the participants attending 3-4, 1-2 or zero group sessions.

Table 3. Intention-to-treat analysis of the total score of HRQoL (SF-36), eating behavior, body esteem and social adjustment, divided by intervention (INT) and control (CON) group, in women pre- and 2-years post-Roux-en-Y Gastric Bypass (RYGB) surgery.

Variables	Pre-RYGB INT (n=122)	Pre-RYGB CON (n=81)	<i>p</i> - value	2y post- RYGB INT (n=122)	2y post- RYGB CON (n=81)	<i>p</i> - value	Cohen's <i>d</i>
SF-36 - MCS	47.0 (0.9)	46.7 (1.2)	0.980	50.3 (1.0)	51.1 (1.2)	0.867	-0.07
SF-36 - PCS	42.3 (0.9)	42.5 (1.1)	0.683	53.5 (0.8)	53.4 (0.9)	0.758	0.01
TFEQ- Total	48.3 (0.8)	48.8 (1.0)	0.669	39.4 (0.8)	39.4 (1.0)	0.985	0.00
TFEQ-CR	13.5 (0.3)	14.8 (0.4)	0.011	14.1 (0.3)	15.4 (0.4)	0.010	-0.36
DEBS	n/a	n/a	n/a	16.7 (2.5)	15.4 (2.9)	0.902	0.05
BES-Total	25.0 (1.2)	25.7 (1.4)	0.659	54.8 (1.6)	57.8 (1.8)	0.299	-0.17
SAS-SR Total	1.6 (0.0)	1.6 (0.1)	0.969	1.4 (0.0)	1.3 (0.1)	0.294	0.09

*INT = intervention group; CON = control group; SF36 = 36-item short-form health survey; MCS = Mental Component Summary score; PCS = Physical Component Summary score; TFEQ-CR = Three-Factor Eating Questionnaire – Cognitive Restraint; DEBS = Disordered Eating after Bariatric Surgery questionnaire; BES = Body Esteem Scale; SAS-SR = Social Adjustment Scale – Self reported. Data presented as mean scores (standard error) for each subscale, *p*-value for the difference between the groups at baseline and 2-year follow-up, effect sizes at 2-year follow-up measured with Cohen's *d*.*

5.2 STUDY II: WELL-GBP AND PHYSICAL ACTIVITY

Of the 259 participants included at pre-RYGB, 167 ($n = 99$ in the intervention and $n = 68$ in the control group) had valid accelerometer measurements at two-years follow-up, which resulted in a loss to follow-up rate of 35.5% (36.5% in intervention group and 34.0% in control group). There were no significant different baseline characteristics between those included in the two-year follow-up ($n = 167$) compared to those not included ($n = 92$), except for age ($p = 0.0097$): the included women were somewhat older (45.5 years, $SD = 10.1$) compared to the ones not included (41.4 years, $SD = 10.6$). There were no significant different baseline characteristics between intervention and control group at pre-RYGB. Of the 99 included participants in the intervention group, 73% had attended at least one group session and 51% had received the intervention according to protocol. No statistical differences were detected between participants who received the intervention according to protocol and the control group. For a table of baseline characteristics, see Table 1 in Article II.

At the two-years follow-up, there were no observed significant differences between intervention and control group in any of the physical activity outcomes (ITT analysis) and the effect sizes were poor ($d = 0.02 - 0.35$). The intervention group spent a mean of 29.0 min per day (standard error (SE) = 1.8) in MVPA and were sedentary for 493.3 min per day (SE = 12.0), while the control group spent 27.1 min per day (SE = 2.5) in MVPA and were sedentary for 458.8 (SE = 12.3) minutes. Sixty-seven percent met the recommended physical activity recommendations in the intervention group, compared to 55% in the control group, however, the differences were not statistically different. Table 4 shows baseline and two-year outcomes for all physical activity outcomes. For details of the one-year follow-up, see Table 2 in Article II.

PP analyzes were performed between participants receiving the intervention and the control group, where the only significant outcome at two-years was sedentary time ($p = 0.002$, $d = -0.58$): the intervention group spent more time sedentary than the control group (522.5 min per day, SE = 17.2, compared to 458.8 min per day, SE = 12.3, respectively) (Appendix I in Article II). However, from a clinical perspective, this difference is believed to not be relevant.

As a sensitivity analysis, all outcomes at the two-years follow-up (the ITT analyzes) were adjusted for wear time, but it did not change any of the results ($p > 0.05$) (non-adjusted analyzes are shown in Table 4). Also, sensitivity analyzes were performed for the participants who had valid accelerometer measurements at all three data assessments (intervention group $n = 68$, control group $n = 36$). These analyzes were adjusted for pre-RYGB outcomes. No statistical differences were observed between the groups. Figure 6 and Figure 7 shows the mean differences of daily minutes of MVPA and daily sedentary time at all data assessments for the groups (not adjusted for pre-RYGB measures).

Finally, sensitivity analyzes were calculated for those participants with ≥ 5 valid days of accelerometer measurements at baseline and two-years follow-up (intervention group $n = 92$,

control group $n = 64$). The intervention group were significantly ($p = 0.047$, $d = 0.35$) more sedentary (500.6 min per day, $SE = 12.5$) compared to the control group (460.8 min per day, $SE = 2.8$), otherwise, no statistical differences between the groups were observed (Appendix 2 in Article II).

Table 4. Intention-to-treat analysis of the different physical activity intensities, measured by the GT3X+ accelerometers and divided by intervention (INT) and control (CON) group, in women pre- and 2-years post-Roux-en-Y Gastric Bypass (RYGB) surgery.

Accelerometer outcomes	Pre-RYGB INT (n=77)	Pre-RYGB CON (n=46)	p- value	2y post-RYGB INT (n=99)	2y post-RYGB CON (n=68)	p-value (Cohen's d)
Mean wear time, hours/d (SE)	14.3 (0.1)	14.0 (0.2)	0.154	15.2 (0.2)	14.7 (0.2)	0.195 (0.35)
Mean counts, min/d (SE)	558.0 (23.6)	564.1 (28.1)	0.714	570.1 (17.6)	579.9 (22.9)	0.858 (-0.05)
MVPA, min/d (SE)	26.7 (2.1)	24.5 (3.1)	0.327	29.0 (1.8)	27.1 (2.5)	0.302 (0.10)
LPA, min/d (SE)	356.3 (10.6)	359.3 (11.1)	0.854	392.4 (9.2)	394.0 (11.2)	0.916 (-0.02)
Sedentary time, min/d (SE)	476.7 (11.9)	455.5 (12.2)	0.235	493.3 (12.0)	458.8 (12.3)	0.075 (0.31)
Mean steps, counts/d (SE)	6176.6 (282.1)	5971.5 (397.9)	0.548	7700.3 (268.5)	7387.8 (366.5)	0.268 (0.11)
Meeting PA-guidelines*, n (%)	43 (55.8)	20 (43.5)	0.184	66 (66.7)	37 (54.4)	0.110 (0.25)
Meeting PA-guidelines in ≥ 10 -min bouts*, n (%)	7 (9.1)	4 (8.7)	0.941	17 (17.2)	13 (19.1)	0.748 (-0.05)

INT = intervention group; CON = control group; MVPA = moderate-to-vigorous physical activity; LPA = light physical activity; PA = physical activity. *PA-guidelines: ≥ 150 minutes of MVPA per week. Presented as mean scores (standard error) or numbers (percent) for each subscale, p-value for the difference between the two groups at baseline and 2-years post-RYGB. Effect sizes at two years measured with Cohen's d. Participants with valid accelerometer measurements at the two-year follow-up were included in the analysis. There are fewer participants with valid measurements at pre-RYGB than at the follow-ups, because not all participants had enough time prior to their surgery to wear the accelerometer.

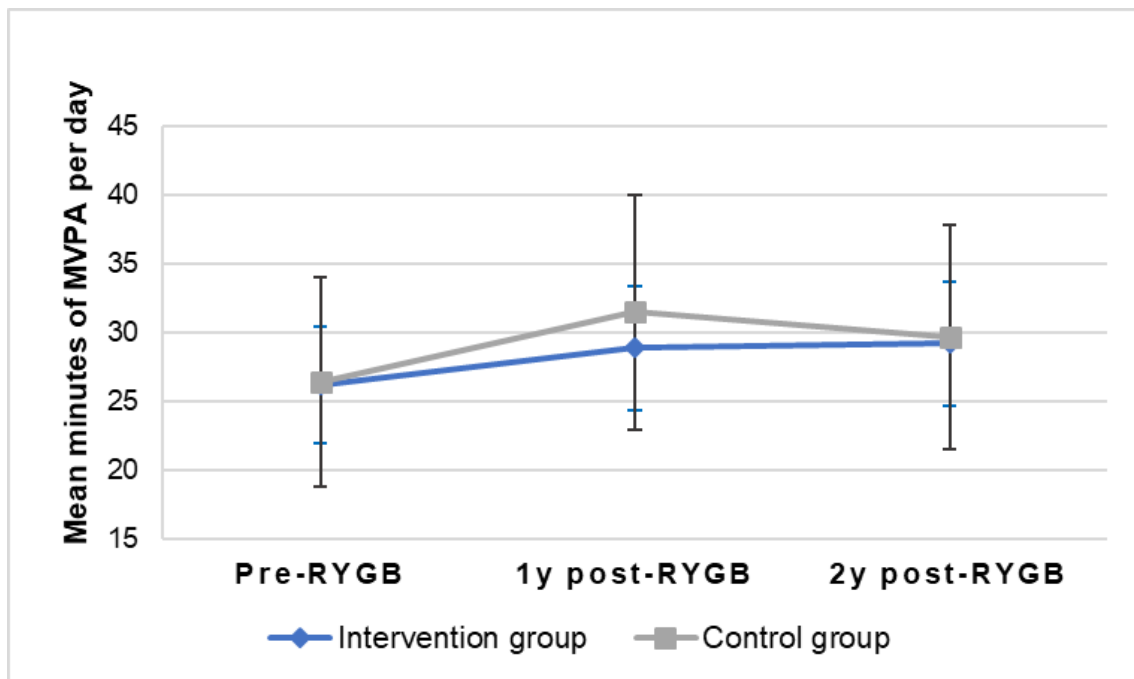


Figure 6. Means of daily minutes of moderate-to-vigorous physical activity (MVPA), with 95% confidence intervals, of the women in the intervention group ($n = 68$) and control group ($n = 36$) who had valid accelerometer measures at pre-, 1- and 2-years post-Roux-en-Y Gastric Bypass (RYGB) surgery.

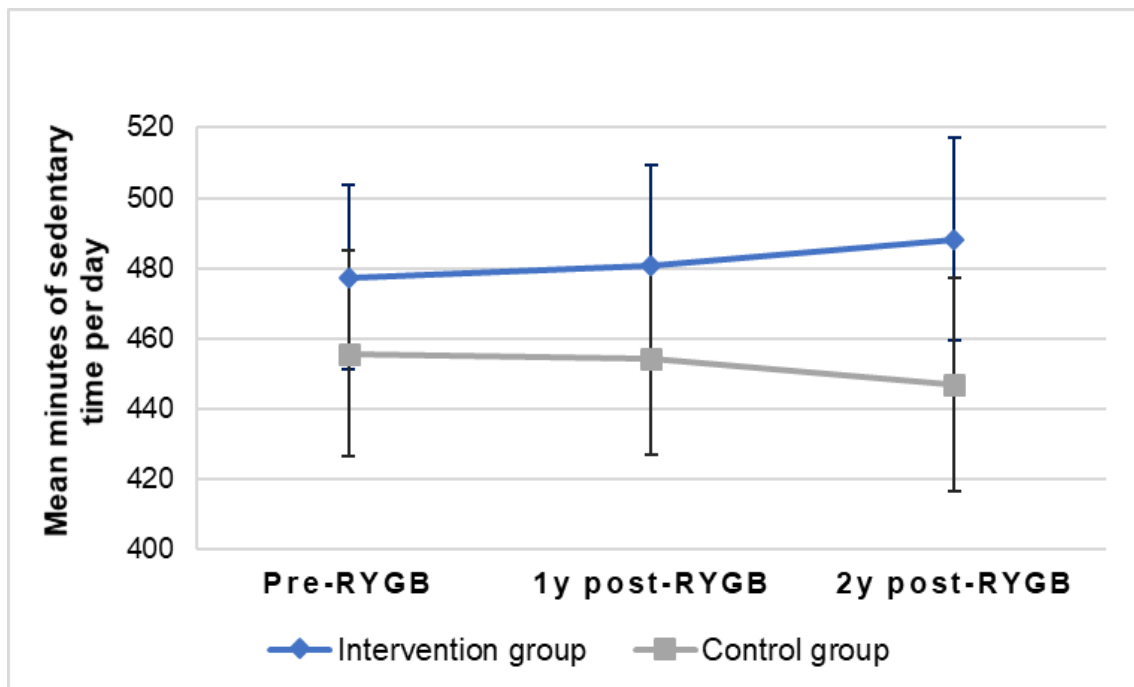


Figure 7. Means of daily minutes of sedentary time, with 95% confidence intervals, of the women in the intervention group ($n = 68$) and control group ($n = 36$) who had valid accelerometer measures at pre-, 1- and 2-years post-Roux-en-Y Gastric Bypass (RYGB) surgery.

5.3 STUDY III: SUBJECTIVE AND OBJECTIVE PHYSICAL ACTIVITY

Twenty-six women with complete questionnaire data and valid accelerometer measurements at pre-, nine- and 48-months post-RYGB were included in this study. Their mean age pre-RYGB was 40.0 years (SD = 6.6) and they had a mean pre-surgery BMI of 38.9 (SD = 3.4). None of the participants had diabetes and 15.4% had post-secondary education or higher (Table 1 in Article III). The majority of them had a sedentary occupation, the prevalence varied at the different data assessments: 61.5% (n = 16) at pre-RYGB, 50% (n = 13) at nine- and 65.4% (n = 17) at 48-months post-RYGB. Pre-RYGB, mean valid days of wear time was 6.6 (SD = 0.9) days, 6.4 (SD = 1.0) days at nine- and 6.8 (SD = 1.3) days at 48-months post-RYGB. Mean hours of wear time were 14.5 (SD = 1.1), 14.8 (SD = 1.3) and 14.8 (SD = 1.3) hours per day, respectively.

When physical activity was self-reported, the domain “exercise” significantly increased from both pre- to nine-months and pre- to 48-months post-RYGB with 8.2 (95% CI = 2.4 – 14.1, $p = 0.004$) and 9.1 (95% CI = 2.9 – 15.2, $p = 0.002$) min per day, respectively. Self-reported total MVPA (“active leisure time” plus “exercise”) significantly increased from pre- to nine-months post-RYGB with 18.0 (95% CI = -0.8 – 36.9) min per day ($p = 0.047$). No other outcomes from the questionnaire were significantly different between the data assessments. None of the outcomes of the accelerometer measurements differed significantly from pre- to post-RYGB (Table 5). To clarify, self-reported MVPA increased with 46.9% and 36.5% from pre- to nine- and pre- to 48-months post-RYGB, respectively, while the changes with accelerometers increased with only 6.1% and decreased with 3.5%, respectively.

Correlations between the self-assessed questionnaire and the accelerometers were poor for all data assessments ($r = 0.21 - 0.42$), and there was only a significant correlation between the two different measurement methods at 48-months post-RYGB ($r = 0.42$, $p = 0.032$) (Table 6). When doing Bland-Altman plots (Figure 8), they showed that the self-reported MVPA were consistently higher compared to the accelerometers during the follow-ups and showed no systematic difference at pre-surgery.

Sensitivity analyzes were performed with the participants who had ≥ 12 hours of wear time per day for ≥ 5 days and with complete questionnaire data at all data assessments, but no significant differences were observed that changed any of the results. Sensitivity analysis was also performed to see if the included participants (n = 26) differed at baseline from the participants in the original cohort that were not included in the study (n = 43). No significant differences were observed in any of the physical activity outcomes or in the baseline characteristics.

Table 5. Physical activity by domain, measured by a self-administered questionnaire and intensities measured by the GT3X+ accelerometers, in 26 women three months pre- (T1) and 9- (T2) and 48-months (T3) post Roux-en-Y Gastric Bypass surgery (RYGB).

Variables (N=26)	T1: Pre- RYGB Mean (SD)	T2: 9m post- RYGB Mean (SD)	T3: 48m post- RYGB Mean (SD)	Difference T1 to T2 (95% CI) <i>p</i>-value	Difference T1 to T3 (95% CI) <i>p</i>-value
Questionnaire (minutes/day)					
Inactive leisure time (TV/reading)	131.5 (79.2)	129.2 (88.1)	120.0 (76.4)	-2.3 (-29.3, 24.7) <i>p</i> =0.963	-11.5 (-42.2, 19.1) <i>p</i> =0.366
Household work	83.1 (54.5)	122.3 (76.3)	103.8 (72.6)	39.2 (16.6, 61.9) <i>p</i> =0.002	20.8 (-6.6, 48.1) <i>p</i> =0.128
Active leisure time (walking/bicycling)	29.6 (35.7)	39.4 (38.6)	34.6 (27.2)	9.8 (-5.3, 24.9) <i>p</i> =0.109	5.0 (-11.6, 21.6) <i>p</i> =0.254
Exercise	8.7 (8.7)	17.0 (10.9)	17.8 (13.1)	8.2 (2.4, 14.1) <i>p</i> =0.004	9.1 (2.9, 15.2) <i>p</i> =0.002
MVPA total (active leisure time + exercise)	38.4 (36.3)	56.4 (43.2)	52.4 (31.1)	18.0 (-0.8, 36.9) <i>p</i> =0.047	14.1 (-3.9, 32.0) <i>p</i> =0.091
Accelerometers (minutes/day)					
MVPA	34.5 (22.6)	36.6 (30.2)	33.3 (22.6)	2.0 (-9.1, 13.2) <i>p</i> =0.869	-1.2 (-11.2, 8.7) <i>p</i> =0.849
LPA	429.3 (96.9)	422.2 (80.3)	430.6 (101.6)	-7.0 (-39.1, 25.0) <i>p</i> =0.869	1.3 (-28.6, 31.2) <i>p</i> =0.970
Sedentary time	406.4 (107.4)	431.4 (95.3)	424.2 (118.3)	24.9 (-4.8, 54.6) <i>p</i> =0.075	17.8 (-15.5, 51.2) <i>p</i> =0.409
Total physical activity	689.5 (228.3)	671.7 (243.3)	674.1 (244.6)	-17.8 (-105.0, 69.5) <i>p</i> =0.304	-15.4 (-101.3, 70.5) <i>p</i> =0.751

CI = Confidence interval; MVPA = moderate-to-vigorous physical activity; LPA = light physical activity. CI derived from paired t-test, p-values between measurement points calculated with Wilcoxon Signed-Ranked test. Presented as mean scores (standard deviation).

Table 6. Comparison between self-reported and objectively measured moderate-to-vigorous physical activity (MVPA), measured by a self-administered questionnaire (domains: active leisure time + exercise) and accelerometers (GT3X+), in 26 women pre- (T1), 9- (T2) and 48-months (T3) post Roux-en-Y Gastric Bypass surgery (RYGB).

Time points	Difference between questionnaire and GT3X+ (95% CI ^a)	P-value of the differences ^b	Correlation ^c (P-value)
T1: Pre-RYGB MVPA (min/day)	3.8 (-10.3 – 17.9)	0.970	0.21 (0.296)
T2: 9m post-RYGB MVPA (min/day)	19.8 (3.3 – 36.3)	0.012	0.25 (0.213)
T3: 48m post-RYGB MVPA (min/day)	19.1 (8.6 – 29.6)	0.003	0.42 (0.032)

^a 95% bootstrap (BCa) confidence intervals. ^b P-values calculated with Wilcoxon Signed-Ranked test. ^c Spearman's rank correlation. CI = Confidence interval; MVPA = moderate-to-vigorous physical activity.

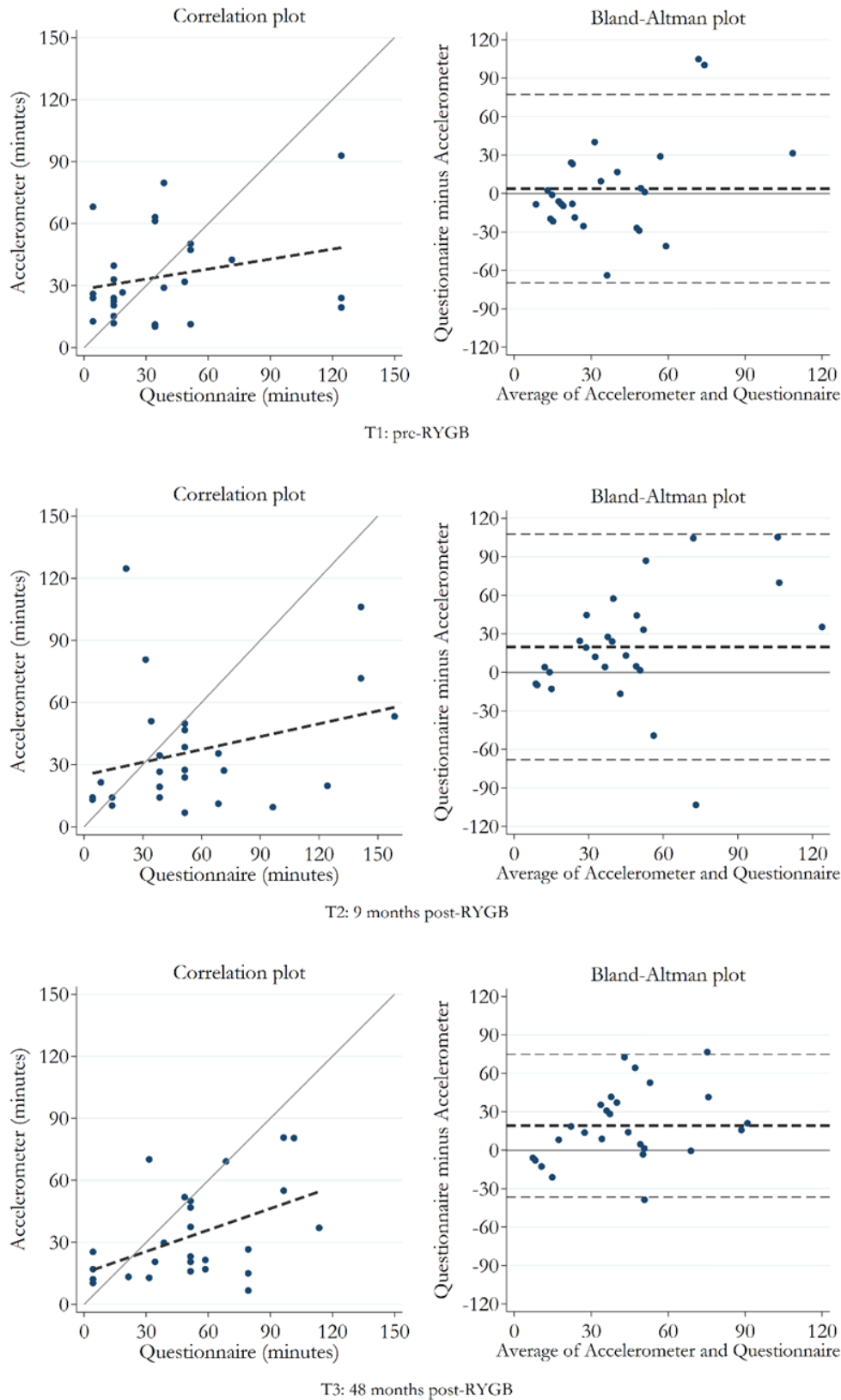


Figure 8. Bland-Altman plots and scatter plots of the correlation between the self-reported and objective measured moderate-to-vigorous physical activity (MVPA) at pre- (top), 9- (middle) and 48-months (bottom) post-RYGB. Left side: Scatter plot with added 45-degree line (solid) indicating perfect agreement, and linear regression line (dashed). Right side: Bland-Altman plot with limits of agreement ($\pm 1.96 \times SD$) and mean difference (dashed).

5.4 STUDY IV: ATTITUDES TOWARDS PHYSICAL ACTIVITY

Eleven women were included in Study IV and had, at the time of the interview, a mean age of 46.2 years (SD = 5.8) and a mean BMI of 26.9 (SD = 3.2) kg/m². The majority of them had a cohabiting partner, children still living at home, worked full-time and an education level between high school and <3 years of university education. Three women had conditions such as chronic disease or a child with special needs, which they expressed affected or impaired their daily lives to various extent.

The core-category was named *Attitudes and surrounding environment influence activity levels* and contained the overall experiences that these participants revealed when expressing thoughts and feelings about physical activity. Three categories were included, each representing an attitude towards physical activity and how it affected the participants' perceived activity behaviors and feelings. Each category comprised several properties. See Table 7 for an overview of the core-category, categories and properties. An explanatory model visualized how the categories and properties related to one another (Figure 9) and how they might help to explain why RYGB-patients are not sufficiently physically active.

Table 7. An overview of the categories and properties that belongs to the core-category “Attitudes and surrounding environment influence activity levels”.

Core category		
Attitudes and surrounding environment influence activity levels		
Categories		
Positive attitudes	Shifting attitudes	Negative attitudes
Properties		
Positive image of PA	Constantly on and off, with some support	Negative image of PA
Challenge myself to improve		Priorities and wishes
To feel healthier and happier		No social support to be active
Social support to be active		Physical limitations for PA
Develop strategies to remain active		Exercise is only equal to dieting

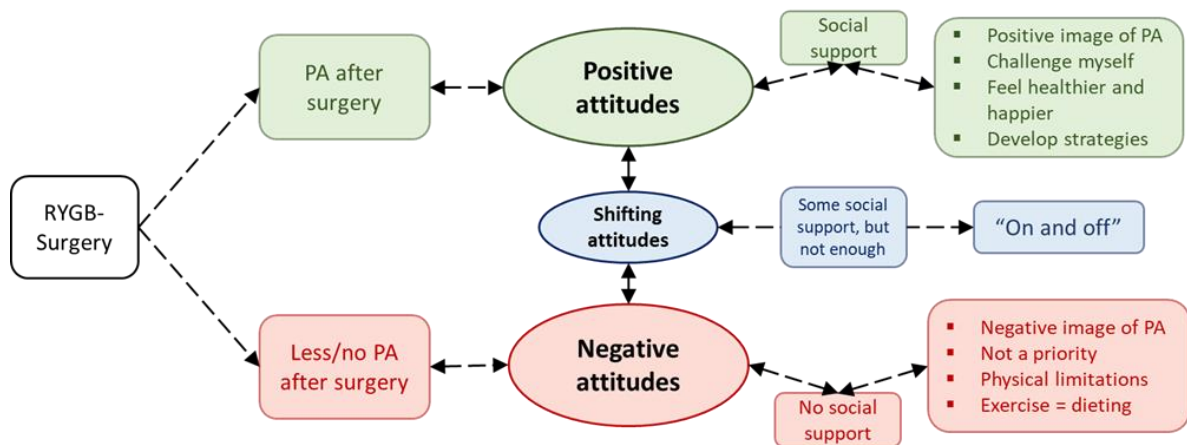


Figure 9. The explanatory model that explains the core category “Attitudes and surrounding environment influence activity levels”.

Below follows a short summary of each category. For more detailed description of each category, as well as quotations from the interviews, see Article IV.

Category: Positive attitudes

Some women revealed a positive attitude towards physical activity. These women perceived themselves as being active on a regular basis, and they had found strategies to keep up with their exercise routines despite work and family. They had a positive image of physical activity as an important part of their daily post-surgery life, and the women presented a variety of performed exercise activities with various intensity levels. Many of these women liked to challenge themselves to always improve in their activities, to for example run or walk a longer distance or lift heavier weights. These women associated physical activity with joy. Physical activity had contributed to make them more comfortable with their new body and they mentioned one or several mental and physical health advantages that they associated with being active. These women also seemed to have support from their social surroundings, either by a partner or having an exercise friend. Also, they were knowledgeable about physical activity, and had found solutions to find an activity and time of day that worked well with the rest of their lives.

Category: Negative attitudes

The women in this category perceived themselves as inactive, with the reason that they didn’t like exercising as they thought it was boring. Most of them described themselves with words like “lazy” or “couch potatoes” during the interviews. One woman thought that physical activity was not necessary if you felt healthy, and another could not mention any positive aspects of physical activity. Physical activity was not a priority, but some women considered to start exercising in the future when their current life situation had changed. Also, they didn’t have anyone in their surroundings to support them, as most of the people in their social

context were inactive as well. Many of them suffered from loose skin after the huge weight loss but did not feel that was a barrier to be active. Some of the women in this category had physical problems that limited their ability to be physically active, such as joint pain or different illnesses that caused pain or tiredness.

Category: Shifting attitudes

This category comprised some of the women who always seemed to move between the two categories *positive-* and *negative attitudes*, as they never seemed to find a balance between physical activity and sedentary behavior. Also, many of them described themselves as “I’m an on or off person”, referring to their episodes, of various length, with vigorous activities several times a week with their motivation on top, followed by episodes of inactivity. These women mentioned that they had social support, like a partner who supported their physical activities, while at the same time they mentioned they had preferred another type of support than the support they had, such as someone who could join them during their exercise.

Almost all interviewed women, but especially those belonging to the category *negative attitudes*, talked about physical activity only as a mean to lose weight. For example, inactive women could not see why they should exercise now, as they already had lost their overweight.

6 DISCUSSION

In this chapter, the main findings of each study will be presented and discussed in relation to previous research, methodological strengths and limitations and end with the implications of the results. Study I and Study II will be discussed together because of their shared study design and data collection.

6.1 STUDIES I - II: WELL-GBP, HEALTH-RELATED QUALITY OF LIFE AND PHYSICAL ACTIVITY

6.1.1 Main findings

The dissonance-based intervention WELL-GBP did not show any differences between the intervention and control groups at two-years post-RYGB (ITT analysis) in any of the outcomes in either the psychosocial outcomes (HRQoL, eating behavior, body esteem and social adjustment) or physical activity levels. All outcomes in the intervention and control groups had improved or increased from pre-RYGB to one-year and were maintained at two-years post-RYGB. Only TFEQ-CR showed significantly poorer eating behavior in the control group, but also differed at pre-RYGB, so this difference might just be random effect. PP analyzes comparing the participants who had received the intervention (attended ≥ 3 group sessions) to control the group also did not show any differences except for sedentary time, where the participants who received the intervention were significantly more sedentary. When analyzing participants with ≥ 5 days of valid accelerometer measurements (sensitivity analyzes) the intervention group was significantly more sedentary than the control group.

6.1.2 Results in relation to previous research

In Study I, both the MCS and PCS of the SF-36 increased from pre- to one- and two-years post-RYGB. The increase was larger in the PCS with almost the exact same scoring in both follow-ups. The MCS, however, increased slightly from pre- to one-year and decreased somewhat at two-years follow-up, though still higher than at pre-RYGB. The same pattern was seen in both the intervention and the control group. This is in line with previous studies, as the physical part of HRQoL increases to a larger extent and is maintained long-term, while the mental part decreases after the first one to two years [12, 13, 92, 97, 196], often with lower scorings than the general population [98].

As previously mentioned, our WELL-GBP trial is, to our best knowledge, the first dissonance-based intervention that have investigated HRQoL in RYGB patients. Therefore, to compare the results from the intervention with previous studies is sometimes difficult and might not always be relevant. Also, few interventions have been conducted with HRQoL, or other psychosocial aspects, as a main outcome. A psychosocial intervention showed that there were no differences in HRQoL between the intervention and control group at approximately three years post-surgery, which is in line with the results from Study I, while the intervention group reported lower depression scores and higher self-efficacy scores than the controls [143]. Similar to the results from the WELL-GBP, a lifestyle intervention that focused on

healthy diet and physical activity, with weight regain as main outcome, did not observe any differences in intake of macronutrients or physical activity levels, as well as no difference in weight regain, between the intervention and the control group [197]. Worth mentioning though, is that a 7-day physical activity recall questionnaire was used to measure the physical activity in that study. Other intervention studies, with weight loss or eating behavior as main outcome, have shown improvements in eating behaviors [140, 198, 199] and depressive symptoms [140, 198], but two of them did not have a control group [140, 198] and the third provided either a mindfulness-intervention or a standard intervention (one hour individual counseling session with a dietician [199]).

A recent study by Jiménez-Loaisa et al. [200] investigated if a six months motivational physical activity intervention (one-month post-surgery) on patients undergoing SG surgery, had effects on physical activity levels and HRQoL (measured by SF-36). The results are in line with Study II as it showed that physical activity did not differ between the intervention and the control group 13 months post-SG. However, in contrast to Study I, three of the domains of HRQoL (physical functioning, bodily pain and PCS) were significantly better in the intervention group at 13 months follow-up.

TFEQ-CR was the only psychosocial outcome that showed an impairment at two-years, in both groups. This might be due to the fact that the TFEQ-questionnaire is not designed specifically for bariatric patients, and therefore the provided response options might not reflect the eating situations of bariatric patients. Two studies from the same cohort of women as Study III, which are based on TFEQ measured before and nine-months [168] and four years [165] after RYGB, showed similar results as Study I: all TFEQ domains improved post-RYGB, except for TFEQ-CR, which got a higher scoring (i.e. poorer eating behavior). Other studies that have used TFEQ for bariatric patients found higher scorings for TFEQ and especially TFEQ-CR, than Study I did, at two [179] and five years [178] post-surgery, but no baseline measures were available. Apart from the TFEQ-CR, the results from Study I are in line with previous research (where TFEQ have been the most used questionnaire): that eating behavior improves and are maintained long-term post-surgery [101, 201, 202].

One intervention by Creel et al. [203] randomized participants to either standard care, only receiving pedometers or receiving pedometers together with counselling sessions. The results showed that the group with both counseling and pedometers increased their physical activity from pre- to six-months post-bariatric surgery [203], though, no long-term follow-up was conducted. This result is not in line with Study II, where no differences in any outcomes between the groups were observed. However, even if the participants in the WELL-GBP trial wore an accelerometer, they could not see the number of steps they had taken as the accelerometer does not give immediate feed-back; the results can only be analyzed through a special computer program. Thus, the study by Creel et al [203] might not be comparable to the intervention in the WELL-GBP trial. Another study randomized RYGB-patients to either a 26-week supervised exercise program or to a control group, and found results similar to

ours: objective measured physical activity tended to increase in the intervention group at one-year follow-up, but were not maintained at two-years [80].

A dissonance-based intervention that aimed to increase physical activity in female college students, showed that directly at post-test, the participants who had received the intervention had increased their physical activity to a greater extent than the control group. However, the increase was not maintained when measured again at six-months post-intervention [204]. Dissonance-based interventions, that focuses solely on physical activity, might thus increase physical activity in short-term, but not at long-term post-intervention.

6.1.3 Methodological considerations

6.1.3.1 The WELL-GBP trial

The main concern for us about the intervention was the large drop-out regarding attendance of the group sessions. Despite enthusiastic participants who seemed genuinely happy when it was announced that they had been randomized to the intervention group, and despite that all dates and times for the sessions were decided together with the participants, only 70 (44.9%) of the total 156 women randomized to the intervention group received the intervention according to protocol, and 103 (66.0%) attended at least one session. Prior to the start of the intervention, a pilot study was conducted that included eight participants, with the aim to test the intervention manual and to see if the sessions were understandable, acceptable and were appreciated by the pilot participants. After each session, the participants provided feedback with thoughts and improvement suggestions, which resulted in small adjustments to the manual. The pilot study was conducted in June 2015, and five of them attended at least one session, indicating that the attendance drop-out might become a challenge.

Our research team have conducted telephone interviews with some of the women in the intervention group who attended zero to two sessions. The interviews were conducted between February to June 2016 and the aim was to explore their reasons for not attending all four sessions. The results are to date under review for a journal, but a short summary of the main conclusions drawn from these interviews were: the majority of the women appreciated the sessions and thought that the support was beneficial for them. However, it was difficult for them to find the time due to family obligations (sick child, no baby sitter), personal or work-related reasons (got sick, too far to travel, changes in work schedules) or they felt they needed other types of support. Some also spoke about that different ways to take part of the sessions could be beneficial, like internet-based or more of a drop-in type of intervention.

The results from the telephone interviews above might be taken into consideration, as another type of delivery of the intervention, like internet-based sessions, or an intervention that is ongoing during a longer time-period and includes more sessions, might be more suitable for this population. For example, a recent RCT that investigated the DBI intervention “the Body project” showed that the internet-delivered intervention did not have as large effects as clinician- or peer-led groups on risk factors and eating disorder symptoms, but had better effects at four-year follow-up than a control group [158]. Moreover, regarding physical

activity, maybe dissonance-based interventions that solely focuses on physical activity might be more effective to increase the physical activity levels post-RYGB. In the present WELL-GBP trial, physical activity was only discussed during one of the sessions.

A longer follow-up time of the WELL-GBP trial would be of interest, as it might reveal any potential effect of the intervention as both intervention and control groups had similar improvements at two-years post-RYGB, indicating that common occurrence of decreases in psychosocial outcomes might manifest later than two years.

Worth considering is also if the right and most appropriate questionnaires were used to measure the outcomes. Even if the questionnaires used in this trial are validated and often widely used (see “*Methodological considerations - Measurements and outcomes*”), it does not exclude that other more sensitive measures would have been more appropriate for the population group studied. For example, the TFEQ might not be the perfect fit for bariatric patients post-surgery (which has already been discussed above). There are also other types of questionnaires that measure different aspects of HRQoL, which could be of interest to combine for further analysis of HRQoL. For future research, and if this trial would be replicated, it could be of significance to look into alternative measurements and also if other types of outcomes could be of interest to capture than those already used in this trial.

The fidelity of an intervention is important to discuss. During all group sessions, the facilitators were videotaped, to be able to determine the quality of the delivery and the adherence of the intervention manual. Unfortunately, the fidelity has not yet been determined for the WELL-GBP trial, so it is not possible to draw any conclusions from it. However, the quality and the adherence of the intervention could alone, or together with the drop-out rate of the participants, explain the lack of effects of the intervention. For the future, and especially if a longer follow-up will be conducted, the fidelity will be important to examine.

6.1.3.2 Strengths

As Study I and Study II derives from the same study group and data collection, the majority of the strengths and limitations apply to both studies. The main strength of Study I and Study II is the RCT-design, because the WELL-GBP intervention can be compared to the standard Swedish post-bariatric surgery care, and any differences in baseline characteristics will be due to chance. The trial was also pre-registered (ISRCTN16417174) and the analysis plan was followed [159].

The intervention was theory-based and took outset in the dissonance-based intervention model developed by Stice et al. [149, 150], which has shown efficacy in preventing unhealthy weight gain [149, 157]. It is also a relatively easy intervention to implement in health care settings, as various healthcare personnel, such as dieticians, nurses, or physiotherapists, can deliver the intervention effectively, after appropriate training [149]. In addition, the intervention is short (four sessions à 1,5 hours each) and thus do not require much time from the healthcare staff.

The results can be generalized to similar settings in Sweden, as the demographic characteristics of the women included in the trial are similar to the general female patients undergoing RYGB-surgery in Sweden [205] and also had similar scores of the SF-36 [196]. What adds to the generalizability is that the included women derived from several hospitals and different geographical areas of Sweden. In addition, surgical practice is quite similar in all hospitals conducting RYGB surgery.

As questionnaires do not provide accurate and unbiased estimates of physical activity in bariatric patients [17-19], the participants' physical activity was measured objectively with ActiGraph GT3X+ accelerometers. As already been mentioned in the methods-section, these accelerometers have been validated to measure physical activity in an accurate way [189]. Inclusion criteria for being counted as a valid accelerometer measurement were at least 10 hours wear time per day for at least three days. Three days were chosen as three to four days of wear time has shown to be sufficient for attaining valid measures of MVPA with 80% reliability [206].

6.1.3.3 Limitations

One reason why the participants, in both the intervention and control groups, had maintained the increased scoring on HRQoL and the other psychosocial outcomes from one- to two-years follow-up, might be due to a selected sample size. Participants who have an interest for and a motivation to try a new method to increase further improvements after surgery, might be more prone to participate in an intervention study such as the WELL-GBP trial. They might also already feel a little more psychosocially stable, compared to bariatric patients who decline participation. The same applies for the absence of differences between the groups concerning the physical activity levels. At the two-year follow-up, 167 of the initial 259 participants had valid accelerometer measurements, which is a loss to follow-up of 36%. This might potentially have caused a selection bias, as participants who were already prone to be more physically active to a higher extent might have taken part in the two-year follow-up. This needs to be taken into consideration when generalizing the results from this trial.

Even if the current study sample seems to be quite representative for the general Swedish female bariatric surgery patients, there are still precautions to consider. Any comparison of our results with other countries should be done cautiously, because the women in this trial had lower BMI at pre-surgery and were somewhat younger than patients undergoing bariatric surgery globally [38]. Only women were included in our trial, therefore any conclusions of the results on men are not possible. Since only patients undergoing RYGB were included, it is not possible to generalize the results to other types of bariatric surgery. Finally, the five hospitals utilized for recruiting participants had slightly different post-surgery follow-up routines, which might have influenced the outcomes, even if Sweden has recommendations for bariatric surgery [42].

One limitation of using the GT3X+ accelerometers is that it cannot differentiate between standing or sitting, which could affect the result of sedentary time because of inaccurate

estimations [207]. Another limitation is that the accelerometers cannot be used in water, so activities like swimming won't be registered. Additionally, these accelerometers have not been validated in bariatric surgery patients. Even if accelerometers have been proven as a reliable tool, doubly-labeled water can estimate energy expenditure in a more accurate way than accelerometers [208]. However, accelerometers were the most appropriate tool available from a cost and feasibility aspect for this trial.

Some limitations of the statistical analyzes need to be considered. When performing the PP- and sensitivity analyzes, smaller sample sizes were used, which might have made the power too small to discover any effect sizes or differences between the groups. Additionally, the power calculation was conducted to detect any differences in HRQoL between the groups and might therefore not have an equally high power for the secondary outcomes, such as physical activity in Study II. Due to higher numbers of missing values than in ITT analysis, there is also a risk of selection bias.

6.2 STUDY III: SUBJECTIVE AND OBJECTIVE PHYSICAL ACTIVITY

6.2.1 Main findings

Women that had undergone RYGB surgery self-reported that their levels of physical activity, especially exercise and total MVPA, had increased nine- and 48-months post-RYGB compared to pre-RYGB. Contrary, objectively assessed physical activity levels remained unchanged from pre- to post-RYGB surgery. There were no correlations between the self-assessed questionnaires and the accelerometer measurements, and Bland-Altman plots showed that the self-reported MVPA was consistently higher than the accelerometers at both follow-ups.

6.2.2 Results in relation to previous research

To our best knowledge, this is the first study to compare self-reported to objectively measured physical activity before and after RYGB in the same individuals, with as long follow-up as 48-months. Previous studies using the same study design have done follow-ups up to six months [17, 19] and nine months [18]. Berglind et al. [18] and Bond et al. [19] observed the same results as in Study III, specifically that the overestimation of physical activity was greater after than before surgery, as the subjective measures increased while the objective measures remained unchanged. Study III therefore reveal that this overestimation remains long-term up to 48-months post-RYGB. In contrast, Afshar et al. [17] did not observe any increases after surgery for any of the measurements. Though, 45 % of the participants in that study claimed they had long-term mental or physical illness or health problems that limited their physical activity on a daily basis.

One study by Bergh et al. [74] compared subjective and objective physical activity: the subjective physical activity (self-reported questionnaire) were measured pre- and up to 24-months post-RYGB, but the objective accelerometer measurements were only measured at post-surgery. In accordance with the results from Study III, the participants highly

overestimated their levels of physical activity compared to the accelerometer data at the post-RYGB assessment. As the study by Bergh et al. did not measure the objectively physical activity at pre-RYGB, it is unknown whether or not the overestimation had increased between the pre- to post-RYGB assessments, as seen in Study III. The prevalence of participants in the study by Bergh et al. [74] who self-reported that they met the physical activity guidelines at the follow-up was 80%, whereas the accelerometers only showed a prevalence of 18% [74]. In Bond et al. [19] the self-reported prevalence was 55% at the six-months follow-up, compared to 5% according to the accelerometers. Pre-surgery, both types of measurements had been identical at 10%.

Berglind et al. [18] did not measure percentage reaching the guidelines, as such a question was not included in the questionnaire (which also applies to Study III). Although, the participants self-reported that their time spent in MVPA had increased by 60% from pre- to nine-months post-RYGB, compared with an increase of only 9.8% according to the accelerometers. In Study III, the subjective increase was 36.5% from pre- to 48-months post-RYGB, whereas the objective measurements showed a decrease by 3.5%, from pre- to 48-months post-RYGB. To summarize, bariatric patients have difficulties to accurately estimate their physical activity after bariatric surgery, and especially the time they spend in MVPA.

Study III confirms that RYGB patients greatly overestimate how physically active they are to a greater extent post-surgery compared to before, which applies to both short- (six- and nine-months) and long-term (48-months) post-surgery. The results therefore implicate that it is of necessity to measure physical activity in an objective way in bariatric surgery patients, particularly post-surgery. Discrepancies between self-reported and accelerometer measured physical activity exist among all people [209], but studies have shown that people with obesity overestimate their MVPA, as well as misclassify the intensity of physical activity, to a higher degree than people with normal weight [210, 211]. Interestingly though is, that patients post-bariatric surgery loses their excess weight and should therefore, like people with normal weight, lead to a more accurate estimation of their physical activity than pre-surgery. However, since the patients included in Study III had a BMI of 27.2 and 26.5 at the nine- and 48-months follow-up respectively, they were still overweight.

One explanation to this post-surgery overestimation of MVPA could be that patients perceive their daily life as much easier after a massive weight loss, as they gain more energy and mobility [81-83, 86], their motivation for and satisfaction of being physically active increases [81, 83, 86], their obesity-related pain decreases [82] and they are not afraid of falling [81]. Moreover, the over-reporting of physical activity might come from an expectation from the society, as well as one's own desire to report improved physical activity behaviors after surgery. These factors could contribute to a feeling of being more active, or at least being able to be more active, and could affect how bariatric patients answers questionnaires about their physical activity. Furthermore, bariatric patients might classify some light intensity activities, like yoga, as an exercise and therefore report it as an exercise-activity in the questionnaire.

However, this kind of activity would not be recognized by the accelerometer as an activity of MVPA-intensity.

It has also shown to be important to measure physical activity objectively, instead of subjectively, due to reasons of health outcomes. Physical activity, that has been measured objectively, has been found to have a twofold stronger relationship to adiposity and other health outcomes, compared to self-reported data [65]. Also, higher levels of any intensity of psychical activity and a reduction of time spent sedentary, is associated with a significantly reduced risk for premature mortality [60].

6.2.3 Methodological considerations

6.2.3.1 Strengths

The greatest strength with Study III is the longitudinal design, together with both subjective and objective measures before and 48-months post-RYGB within the same individuals. That enabled us to control for factors that are otherwise difficult to measure, but constant over time within individuals, for example genetics. To measure the objective physical activity, ActiGraph GT3X+ accelerometers were used. As already have been mentioned above in chapter “*Methodological considerations – Strengths*” in Study I and Study II, they have been validated as an accurate tool for measuring physical activity [189] and the three days of valid wear time was chosen as this is enough for assessing MVPA with 80% reliability [206]. A strength with the self-administered questionnaire was that it can capture occupational physical activity or household activities, activities that cannot be measured by accelerometers [187].

6.2.3.2 Limitations

Study III included a small sample of 26 participants, which limited its statistical power. However, previous studies with the same study design have included 20 [19] and 22 participants [17], and the previously published nine-month follow-up of the same cohort as in Study III, had 43 participants [18]. With respect to gender, age and education level, the current sample is quite homogenous. Only patients that underwent RYGB surgery were included. All these factors could affect the generalizability of the results to other population groups.

Participants who did not have complete questionnaire- and accelerometer data were excluded, which might have led to selection bias where only the already active participants agreed to participate. Nevertheless, sensitivity analyzes were conducted where the original cohort (n = 69) were compared to the participants included in Study III (n = 26) for descriptive and anthropometrical characteristics. Also, the included participants were compared to the ones with non-complete data (n = 43) for baseline characteristics and pre-RYGB physical activity outcomes. No significant differences were found.

There are some limitations with using the GT3X+ accelerometers, which have already been mentioned briefly above in the chapter “*Methodological considerations - limitations*” in Study I and Study II. In short, they are not able to distinguish between standing or sitting [207], cannot be used in water, have not been validated in bariatric surgery patients and are not as an accurate tool as doubly-labeled water [208]. Nevertheless, from cost and feasibility aspects of the current study, accelerometers were the most appropriate tool available.

One limitation with the physical activity questionnaire was that the pre-defined category “exercise” only specified the duration of an activity, but not what kind of activity or its intensity. This could lead to misclassifications of physical activity intensities, which has been discussed above in the discussion chapter “*Discussion - Results in relation to previous research*” for this study.

6.3 STUDY IV: ATTITUDES TOWARDS PHYSICAL ACTIVITY

6.3.1 Main findings

The core category *Attitudes and surrounding environment influence activity levels* summarizes the main findings of this interview study about women’s perceptions and experiences of physical activity five years after RYGB surgery. The women’s own attitudes towards physical activity, and if they had support from their closest environment or not, seemed to influence their self-perceived physical activity. Women with *positive attitudes* to being active and had hands-on support from their family and friends were more prone to be active on a regular basis. Whereas, the women with *negative attitudes* seemed to lack social support and had low self-perceived levels of physical activity. Some women also belonged to a category of *shifting attitudes*, where they had periods of regular MVPA, followed by periods with no activities, never being able to find a balance. These women seemed to have social support to be active, but not in the way or to the extent they seemed to need. Also, there seemed to be a common perception among participants that physical activity was only regarded as a mean to lose weight.

6.3.2 Results in relation to previous research

Previous studies investigating physical activity after bariatric surgery have also observed that attitudes towards physical activity, positive or negative, are sometimes present, but the attitudes have often been included briefly in categories of barriers and facilitators for being active [83, 212]. Most of these studies have usually investigated the barriers and facilitators to be active, and then categorized them in internal or external factors [81, 82, 84], but have not mentioned attitudes as major reasons for (in)activity. Moreover, to our best knowledge, the sub-group of women that were found with shifting attitudes has not previously been identified among bariatric patients.

A recent study by Beltran-Carillo et al. showed that all bariatric surgery patients who had participated in an exercise program had, directly after finishing the program, intentions to be physically active in the future. They also felt that they had attained all the knowledge and

tools needed to be physically active on their own, without the support from the program. Despite these intentions and knowledge, it seemed difficult for many of the patients to actually take the step to create an active lifestyle [88]. This study by Beltran-Carillo et al. [88], as well as a study by Wiklund et al. [81], have similarities with our findings in Study IV focusing on attitudes to physical activity. These authors have described how unfavorable/bad weather seemed like a “mental obstacle”, which has similarity with our results in Study IV, that bad weather derived from low motivation and a negative attitude to physical activity. Contrary, a study by Peacock et al. [84] mentioned that bad weather was an environmental and external barrier. This could be related to Study IV; if you have a positive attitude towards physical activity, unfavorable weather will not be a barrier as you probably will carry out your planned activity anyway. But with a negative attitude, a weather-factor could cause you to cancel any eventual plans for exercise.

Similar to the findings in Study IV, Beltran-Carillo et al. also showed that having social support was considered crucial for being able to maintain an active lifestyle, and especially to have a companion for physical activities [88]. Having a companion when doing exercise was something that was often mentioned by the participants in Study IV, especially among the women with the shifting attitudes. They expressed that they had support from their partners to go to the gym, but missed a companion that could actually exercise together with them. Lack of social support has been seen as a barrier to be active post-bariatric surgery in many qualitative studies [82, 83, 86], in accordance with the conclusions of Study IV. The results of Study IV are also in line with research about social support and physical activity not related to bariatric surgery [213-215]. Systematic reviews have confirmed that social support from family or friends is important for physical activity among men and women [213], older adults [214] and adolescents [215].

An interesting finding of Study IV was that the majority of the interviewed women expressed several mental and physical advantages and aspects of being physically active on a regular basis that was not related to weight loss. But despite this, the women, and especially those with *negative attitudes*, expressed that physical activity was only a mean to lose weight. During the interviews, when being asked if they thought there were any positive aspects of being active, the women stated several reasons, but then later on expressed in some way that physical activity was a great option only when they wanted to lose weight. Some of them also had weight loss as a motivator for exercising, thus after surgery, exercise was no longer needed as they had lost their severe obesity.

Other interview studies have found similar results: bariatric patients perceived that exercise after surgery was not necessary during the first half-year post-surgery, as the weight loss happened anyway due to the surgery [82] and weight loss, or to prevent weight gain, was the only motivator for being physically active [83]. Equivalent results have been seen when interviewing individuals with obesity that participated in an exercise program: the participants mentioned several health-benefits of physical activity that were non-weight related, but their primary motivation for exercising was anyway to lose weight [216]. This is

to some extent contradictory to findings in other studies, that have shown that patients post-surgery experiences increased motivation and satisfaction with being physically active [81, 83, 86]. Nevertheless, to conclude, one reason why majority of bariatric patients fails to be sufficiently active post-surgery might be that they do not see the point of exercising if the only, or the primary, motivator for being physically active is weight loss, as the surgery itself initially takes care of that issue.

This common misperception, that physical activity is only a mean to lose weight, is problematic in several ways. First, weight loss is not an effective motivator for being physically active, as these women, and other people that undergo bariatric surgery, lose large parts of their excess weight due to the surgery itself, especially during the first year. Second, the statement that exercise is good for weight loss is not true, as exercise alone has not been proven to be an effective method for long-term weight loss [217]. Physical activity is, though, an important factor that can contribute to weight loss maintenance [63].

6.3.3 Methodological considerations

6.3.3.1 Strengths

The main strength of this study is the wide variation of perceptions and experiences these women have expressed during the interviews, that varied from very positive experiences to very negative. They were very open-hearted as they shared both personal and intimate challenges and insights regarding their post-surgical experiences. Despite their views and attitudes towards physical activity, they seemed to spoke out of honesty, as the researcher who conducted the interviews (SP) got the feeling that they did not try to appear more active or in a more favorable way than they were. The interviewer assured them, before the interview began, that this was not a hearing where they were supposed to report how “good they behaved” after surgery, but that we simply wanted to know their real experiences and perceptions as to gain more insight and knowledge that could improve the post-surgery healthcare. Maybe this contributed to their openness which might have strengthen the trustworthiness of the findings.

To improve and attain the transferability of the results, rich and detailed descriptions of the procedure of the interviews and all stages of the analysis, as well as the participants backgrounds and certain circumstances that could affect their perceptions and experiences, were provided. Dependability of the results was achieved by using audit trails throughout the process, like going back to the memos and the transcripts of the interviews to assure the results were grounded in the data and used a transparent and easily visible coding strategy. Also, an audit trail was made of all the changes done in the interview guide, because of the emergent design, and any changes made to the constructions of properties and categories. All interviews were conducted by one researcher (SP), which also added to the dependability of the results and reduced the risk for a biased procedure of the interviews. Several steps were taking to achieve confirmability. Several researchers with different backgrounds were involved in the analysis process and discussed the findings, to minimize the risk of inventing

data or getting a biased interpretation. The results were also discussed through peer-reviewing during seminars with research colleagues that did not belong to the research group. Thus, triangulation was used. With these steps taken, the credibility of the findings was enhanced. This also reduced any possible biases of the results and secured trustworthiness of the results.

As previous research have shown that bariatric patients overestimate their physical activity post-surgery [17-19], as well as misclassify the intensities of physical activity to a higher extent than people with normal weight [211], the participants were asked of their perceptions toward physical activity in general, and not specifically MVPA. This was due in order to capture the experiences and perceptions of all levels of physical activity, and so that the participants would not leave out any experiences just because she didn't assume that it was of less importance. Nevertheless, with this approach, the women were also asked about their views on the differences between physical activity and MVPA/exercise. The women often used the word "exercise" for activities that can be categorized as MVPA.

6.3.3.2 Limitations

Thirty-eight women were invited to participate in the interview study, but of those, only 11 interviews were conducted. This might have led to a biased sample, as there might be a risk that only the women who were active and wanted to share their story agreed to participate. Also, because this is a group of people often stigmatized in society and probably not sufficiently physically active, there might be a reluctance to participate in this kind of study.

Only participants from the cohort that had participated in all three follow-ups (pre- nine- and 48-months post-RYGB) were invited, which also might add to a biased sample in which only the already motivated and/or active participants are included. However, as already mentioned, these women were very outspoken and talkative and revealed variations of perceptions and experiences that were of both positive and negative nature; thus, the results reflect a variety of different physical activity behaviors and perceptions towards physical activity post-surgery.

The interviews were also conducted during different seasons, from the months of spring and summer to the months of winter, which might have affected the participants physical activity behaviors. However, the questions asked during the interviews were broad and was meant to capture their overall perceptions of physical activity, which are not season bound. One question in the interview guide specifically asked the participant to describe her physical activity during the last month, but this question was always followed up with supplementary questions if this was normal for how it used to be, and usually the discussions targeted the participants overall physical activity behavior during a year. Therefore, seasons should not have had any major impact on the findings.

6.4 IMPLICATIONS OF FINDINGS

The results from the WELL-GBP trial (Study I and Study II) showed that a DBI post-RYGB surgery had no intervention effects on HRQoL, eating behavior, body esteem, social adjustment and physical activity in women two-years post-RYGB. A follow-up time longer

than two-years might be necessary in order to see any possible preventive long-term effects of the intervention on the psychosocial outcomes. The research team are planning to conduct a five-year follow-up of this trial, planned to start in 2020, and it will be of great interest to see if there will be any intervention effects more long-term. However, if any differences between the intervention and the control group would be observed at five-years, it would not be known if the intervention was effective or if it was just beneficial for the women to meet other peers that were going through the same experience. Maybe the ultimate RCT, in this case, would be to have three arms: one control group, one intervention group and one group where participants met and talked but about topics not related to dissonance-based theory. Future research should also try to deliver the intervention in a different way, for example internet-based, or a combination of face-to-face meetings and internet-based sessions, to see if that could increase the rate of attendance. It might be beneficial to include more sessions during a longer time-period too, in order to see any effects on the psychosocial outcomes, and to have a DBI that only focuses on improving physical activity. Future studies should also include male-patients.

The results from this thesis implicate the necessity of measuring physical activity in an objective way in bariatric surgery patients, particularly post-surgery, in research studies. This is especially important as objectively measured physical activity, in comparisons to subjectively measured physical activity, has a twofold stronger relationship to adiposity and other health outcomes [65]. Furthermore, objective tools, such as accelerometers, should also be used in the post-surgery healthcare. In that way, the healthcare personnel could discuss and enlighten the patients about their physical activity levels post-surgery, together with information about the current physical activity guidelines and how physical activity can optimize the results after surgery and enhance the weight loss. Also, patients should be encouraged to use devices to measure their own daily physical activity, such as mobile applications, pedometers or smart watches, to enable them to learn about their own physical activity behavior and how different kind of activities are registered in the devices as well have different health advantages. Furthermore, more qualitative research is needed in this area to understand why the overestimation of physical activity is greater after RYGB surgery compared to before. When the reasons for patients' overestimation is known, more targeted interventions and accurate post-surgery healthcare can be delivered to bariatric patients post-surgery.

The results from Study IV, with the attitudes in focus, could be a new additional aspect to consider physical activity post-surgery and in the post-bariatric surgery healthcare, and could be helpful when planning and implementing interventions. Maybe interventions that focuses to target and change attitudes first, instead of behavior, needs to be addressed and researched on. Also, to gain more knowledge in this area, better support post-surgery can be given to the patients that are in most need. If the healthcare could utilize tools to identify the patients in most need of support, for example patients with negative or shifting attitudes, resources could be distributed where they are most needed and be delivered in an individualized way.

The findings also highlight that it was common to think that physical activity was only necessary when wanting to lose weight. These findings therefore highlight a need for getting patients to gain knowledge about why physical activity is important, especially post-surgery, and also help patients to gain the “right” kind of motivators, for examples all the various positive health consequences that derives from being physically active. Then, the patients might attain a sustainable physical activity behavior with motivators that do not derive from one’s weight. If this could be achieved, patients would not have the false idea that physical activity is not necessary the first months after surgery [82], and the post-surgery support could help optimize and improve the patients’ health and wellbeing outcomes long-term post-surgery. Hospitals conducting bariatric surgery could also offer exercise groups for bariatric patients, where they could find social support from other like-minded people in a safe environment where, hopefully, a more positive attitude could be developed.

Therefore, it would be interesting if future research could investigate and focus on to which extent bariatric patients’ attitudes have on physical activity, and whether or not interventions can influence the attitudes towards a positive direction. Also, this topic would need to become more prioritized in the healthcare setting, and it would be beneficial to develop a tool that could target the patients in most need of support who have negative attitudes, so that they could be strengthened and empowered after their bariatric surgery.

7 CONCLUSIONS

Dissonance-based interventions have previously shown positive effects on various health-behaviors and they consist of few and short group sessions, which are easy to implement in a healthcare setting. To our best knowledge, DBIs have never been conducted in RYGB-patients with the aim to prevent a decline in HRQoL post-surgery. Nevertheless, the effects of the intervention were poor and there were no significant differences (of clinical relevance) between intervention and control groups on HRQoL, eating behavior, body esteem, social adjustment or physical activity at two-years post-RYGB. However, all psychosocial outcomes had improved from pre- to one-year post-RYGB and were maintained at the two-years follow-up.

Women that have undergone RYGB surgery overestimate their time spent in MVPA to a much greater extent nine- and 48-months post-RYGB than they did before their surgery. The self-reported exercise and total MVPA significantly increased, in contrast to the accelerometer measurements that were constant from pre- to all follow-ups. These findings therefore confirm that the great overestimation that previously has been reported up to nine-months post-bariatric surgery, still exist up to 48-months post-RYGB.

Interviews with women five years after RYGB surgery about their experiences and perceptions of physical activity showed that their self-perceived physical activity seemed to be associated with their positive or negative attitudes towards physical activity, as well as if they felt they had enough support to be physically active from their closest environment. Moreover, some women showed shifting attitudes where they were not able to find a sustainable balance between physical activity and sedentary behavior, and in addition did not felt they had enough, or the right kind, of support. To our best knowledge, this sub-group has not previously been identified in bariatric patients. Additionally, the majority of the interviewed women perceived physical activity only as a mean to lose weight, which can be problematic as weight loss often is a general motivation for becoming physically active. As bariatric patients experience surgery-induced weight loss, their motivation consequently fades and their attitudes for physical activity post-surgery might be affected and perceived as not necessary.

8 POPULÄRVETENSKAPLIG SAMMANFATTNING

Andelen av människor med övervikt och fetma har under de senaste decennierna ökat kraftigt runt om i världen och övervikt och fetma är idag kopplat till fler dödsfall globalt än undernäring. För att kunna klassificera fetma används Body Mass Index (BMI), definierat som kg/m^2 , där normalvikt klassificeras som BMI mellan 18.5 – 24.9, övervikt som $\text{BMI} \geq 25$ och fetma som $\text{BMI} \geq 30$. I Sverige så har hälften av befolkningen övervikt eller fetma, där andelen med fetma är 16% hos männen och 15% hos kvinnorna: det är en tredubbel ökning sedan 1980-talet. Övervikt och fetma ökar risken för att drabbas av flera olika sjukdomar, till exempel hjärt- och kärlsjukdomar, diabetes typ 2, hypertoni och vissa typer av cancer.

Den mest effektiva behandlingen som finns mot fetma är viktnedskningsoperationer, till exempel Gastric Bypass. Operationen går ut på att magsäcken minskas för att begränsa matintaget och tunntarmen koppas om för att även minska näringsupptaget. Efter operation krävs att patienten ändrar många av sina ät- och hälsobeteenden för att kunna behålla de positiva effekter som operationen ger. Genomsnittlig viktnedskning efter operation är cirka 30% under det första året, då även majoriteten av patienter upplever en ökad hälsorelaterad livskvalitet, förbättrat ätbeteende och andra psykosociala positiva hälsoaspekter. Dock verkar denna förbättring endast temporär, då speciellt den mentala delen av hälsorelaterad livskvalitet ofta ses minska ett till två år efter operation. Trots att det verkar finnas ett behov för patienter att få stöd i dessa förändringar för att få bra förutsättningar för att kunna anpassa sig till den nya livsstilen, erbjuds det idag inget sådant stöd inom den svenska sjukvården.

Att vara tillräckligt fysisk aktiv (WHO rekommenderar minst 150 minuter per vecka av medel- till högintensiv fysisk aktivitet) är extra viktigt efter en Gastric Bypass, då det är kopplat till bland annat ökad viktnedskning, ökad förlust av fettmassa och minskad förlust av muskelmassa. Att vara tillräckligt fysiskt aktiv efter operation har i vissa studier även visat ett samband på högre hälsorelaterad livskvalitet. Dock är patienter som genomgår dessa operationer inte tillräckligt fysiskt aktiva, varken före eller efter operation. Det har visat sig att Gastric Bypass patienter överskattar sin fysiska aktivitet till en mycket högre grad efter operation, jämfört med före. Dock har inga längre uppföljningar än nio månader efter operation gjorts på dessa studier. Man vet inte varför Gastric Bypass patienters överskattning ökar efter operation, och det saknas även intervjustudier, som genomförts flera år efter operation, som undersöker bakomliggande faktorer till varför så få patienter är tillräckligt fysiskt aktiva.

Syftet med denna avhandling var att undersöka om en dissonans-baserad gruppintervention kunde förhindra försämringen (som brukar ske ett par år efter operationen) av hälsorelaterad livskvalitet, ätbeteende, kroppsuppfattning och social anpassning, samt öka den fysiska aktiviteten, hos kvinnor två år efter deras Gastric Bypass operation. Interventionen bestod av fyra gruppträffar, där kvinnor tre månader efter operation träffades och diskuterade hur de skulle agera och bemöta eventuella vanliga problem som kan uppstå efter en Gastric Bypass. Teman som diskuterades var fysisk aktivitet, ätbeteende, sociala- och intima förhållanden.

Andra syften var att se om den ökade överskattningen av fysisk aktivitet efter Gastric Bypass fortfarande existerade fyra år efter operation, samt att utforska Gastric Bypass opererade kvinnors uppfattningar och upplevelser av fysisk aktivitet fem år efter operation.

Studie I och Studie II undersökte effekten av interventionsstudien, men inga effekter på hälsorelaterad livskvalitet, ätbeteende, kroppsuppfattning, social anpassning eller fysisk aktivitet kunde ses när interventionsgruppen jämfördes med en kontrollgrupp två år efter Gastric Bypass. Trots att deltagarna visade stor entusiasm och uppskattning inför att få delta på dessa gruppträffar var deltagandet lågt, och framtida forskning bör överväga andra sätt att erbjuda ett liknande gruppstöd.

Studie III visade att överskattningen av fysisk aktivitet fortfarande bestod 4 år efter Gastric Bypass operation. Den självrapporterade fysiska aktiviteten hade ökat med 36,5% från före- till 4-år efter operation, jämfört med resultatet av rörelsemätarna som visade på en minskning av 3,5% från före- till efter operation.

Studie IV upptäckte ett möjligt samband mellan attityder, socialt stöd och självuppskattad fysisk aktivitet. De kvinnor som hade en positiv inställning till fysisk aktivitet och kände ett socialt stöd för att vara aktiv, upplevde sig själva som mer fysiskt aktiva och hade hittat lösningar på hur de kunde få till en regelbunden vana av fysisk aktivitet. Situationen verkade vara tvärtom för de kvinnor som hade en negativ inställning och inte kände att de hade socialt stöd. Vissa kvinnor hade en skiftande attityd, där de hoppade mellan perioder av mycket fysisk aktivitet och positiva attityder, till perioder med lite eller obefintlig fysisk aktivitet kantad av negativa attityder, samt en känsla av att ha ett visst socialt stöd men inte på det sätt som hade önskats. Majoriteten av kvinnorna som intervjuades tyckte att fysisk aktivitet och träning endast var ett medel för viktninskning.

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